Alberta Research Council 1983 Annual Report

The Alberta Research Council is a crown corporation of more than 500 employees promoting responsible economic development in Alberta through a broad range of research in science and technology — Oil Sands, Coal, Industrial & Engineering Research, Natural Resources, and Frontier Sciences thought to be of future economic benefit to the province. The Alberta Research Council is located in Edmonton and has offices in Calgary, Red Deer, Nisku and Lethbridge.

Letter of Transmittal

To The Honorable Peter Lougheed
Premier of the Province of Alberta

In accordance with the requirements of the Alberta Research Council Act, I have the honor to present to you the Annual Report of the Alberta Research Council for the calendar year 1983.

Respectfully submitted,

Eric C. Musgreave, M.L.A.
Chairman, Alberta Research Council

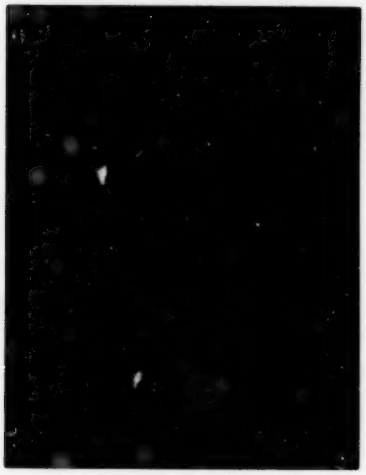
March 1984

Table of Contents

84- 3002 /

Chairman's Message 4
President's Report 5
Industrial & Engineering Research 7
Frontier Sciences 11
Oil Sands Research 15
Coal Research 19
Natural Resources Research 23
Information and Support Services 27
Financial Statements 31
Board of Directors 38
Senior Management Staff 39

Particles of coal flow down a pipeline, through a water slurry, in an experiment on agglomeration and simultaneous beneficiation of fine coal in long distance transportation.



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Chairman's Message

The Alberta Research Council is constantly changing as it aids Alberta's industrial growth through science and technology. Symbolic of our progress in fulfilling our mandate was the further development of our facilities in 1983.

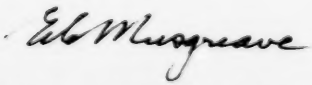
Construction started on the main building of our new permanent headquarters in southeast Edmonton, adjacent to the Edmonton Research and Development Park. The high head laboratories, to be connected to the main building, were largely completed in 1983 and the warehouse for storing equipment and supplies was completed and now is in operation.

Installations were completed at an interim high pressure facility for coal research in Nisku, and construction continued in Devon on a permanent coal research center, financed by the Alberta/Canada Energy Resources Research Fund. We will be sharing the building with the staff of the Coal Mining Research Center and the federal Department of Energy, Mines, and Resources.

I take great pleasure in welcoming a new member to our Board of Directors, Dr. Gordin Kaplan, Vice-President of Research at the University of Alberta who has made many contributions to science at the national and international levels.

On behalf of the Board, I would like to thank Dr. Gilles Cloutier for his outstanding contributions to this organization and to the province. As President, he brought about a major reorganization of the Alberta Research Council and expanded its research activities in the past five years so that it could become the integral force in the province's economic development that it is today. In recognition of his major contribution to the province, the University of Alberta presented him with the degree of Doctor of Science, Honoris Causa, at its fall convocation. He also served on the Board of Directors. I wish him every success in his new senior position with Hydro-Québec in Montreal.

The success of the Alberta Research Council will depend in 1984, as it has in the past, on the continued positive support of all employees in fulfilling our mandate.



Eric C. Musgreave, M.L.A.
Chairman, Alberta Research Council

President's Report

The directions and relevance of research activities at the Alberta Research Council were given careful review and consideration by the senior management group during 1983, especially since changes in the economic environment have imposed constraints on growth proposed in the Long Range Plan. This review also examined the relationship of these activities to the province's economic strategy, also the subject of careful evaluation by the government.

A continuing dilemma of a research organization with a predominantly "applied" mandate is maintaining an acceptable balance between research in the short-term and that with a long-term return on investment. Also, it is never possible to carry out all research projects proposed from both within and outside the organization. The research process inevitably starts with risk decision-making on where to invest the funds and manpower resources available, based on estimates for the probability of success.

One decision made during the senior management review was that the Alberta Research Council should place more emphasis on high technology, especially in areas which offer considerable potential for broadening the province's industrial base. The Research Council has acted on this decision by taking several initiatives to define more specifically where the needs and opportunities lie. In January, the Alberta Research Council invited proposals from companies in the province to join in joint research ventures on projects in high technology areas and offered to share costs on a fifty-fifty basis; the Research Council was prepared to spend up to $500,000 yearly on any one activity. The very considerable response of over 30 good proposals — almost all in computing related fields — was more than the Research Council could accommodate with the funds available. To date, a three-year contract has been signed with Nortech Surveys Inc. of Calgary, for a $1.6 million joint research project to develop a computer-based navigational system for fixed-wing aircraft. Other contracts are under development.

The Alberta Research Council also participated with representatives of industry, universities and government in proposing that Alberta establish a center for designing and fabricating custom microelectronics chips to support industry. The proposed center would assist industry to maintain and increase its competitiveness in international markets, particularly in petroleum and agriculture-related areas. A business plan to support this proposal is being formulated in concert with Alberta Economic Development.

During the year the Alberta Research Council also established a task force to evaluate the opportunities for Alberta in high technology areas. This task force has drawn extensively on advice and assistance from industry and the universities, and based on the report, advanced technology programs are now being developed.

To establish new research programs in high technology, during a period of economic restraint, the Alberta Research Council has made some difficult decisions to reduce activities severely in some of its traditional fields of research in order to free resources for the new areas. Because new types of skills are needed, these decisions inevitably and

regretably have led to concomitant decisions to reduce staffing levels in some areas. These decisions were announced to the staff at the end of the year and will be implemented early in 1984.

Another area seen as an opportunity for establishing an Alberta industry is biotechnology. In 1983 the Alberta Research Council re-oriented its biological activities to areas more likely to yield an economic return in a shorter time-frame. The joint research venture with BIO LOGICALS inc., of Ottawa, is designed to lead to the development of pharmaceuticals and specialty chemicals. In this field, however, scale-up for commercial production is still somewhat difficult. The Alberta Research Council will establish in its new facilities, in southeast Edmonton, a pilot plant project to handle scale-up problems in the production of biological products. These pilot facilities will be available early in 1984, although the main building is not expected to be completed until early in 1985.

Dr. Don Gerson's considerable expertise in this field of research, gained in universities and industry, will be particularly valuable in development of this program and in his position as the new Head of the Biotechnology Department.

The Alberta Research Council's activities in oil sands research are directed towards finding a new process, or new processes, for recovering bitumen economically from the more deeply buried oil sands deposits. Much of the cost for this activity is jointly shared with the Alberta Oil Sands Technology and Research Authority (AOSTRA), but the Research Council also carries out projects on behalf of a number of industrial clients. We were pleased to sign a new three-year contract in January, for instance, with Texaco Canada Resources Ltd. to extend the research we have been doing on their behalf for a number of years. In September, the Board of Directors of Texaco Canada Ltd. visited our Clover Bar research facilities during their annual meeting in Edmonton.

The experimental units for the Coal Research Program in the interim facilities at Nisku became fully operational in 1983. Researchers in this program were able to evaluate seven Alberta coals on their suitability for several different processes for converting coal into various liquid fuels. Glacial geology studies turned out to have a useful application in Alberta surface coal mines, in that this type of work can now be used to predict and define problems in the stability of mine walls.

Research staff in the hail and rain field were successful this year in developing a computer system by which radar data gathered at the Red Deer field station can be immediately transmitted to Edmonton, displayed as rainfall maps on video screens, and interpreted to produce maps of total rainfall. The application of this research is in predicting flood conditions in areas between Edmonton and Calgary in the event of heavy rainfall.

The new, more active, role which the Alberta Research Council has taken in the past five years is reflected in its new visual identity. The organization's new logotype, seen on the cover of this report, not only reflects our goals, but the attributes of science and technology.

In addition to the research program achievements that I have mentioned, a number of staff members received recognition from their peers for the quality of their research work. I would like to offer my congratulations to: Dr. Sat Parkash who was elected as a Fellow of the Chemical Institute of Canada and also as a Fellow of the Royal Society of Chemistry in London, England; Drs. Eddy Isaacs and Daniel Prowse, and Joseph Rankin who received the Best Paper Award for 1982 from the Journal of Canadian Petroleum Technology; Dr. Koichi Takamura who received the Best Paper Award for 1982 from the Canadian Journal of Petroleum Engineering; Dr. George Pemberton who was a co-author of the Outstanding Paper Award for 1982 from the Journal of Paleontology; and Mrs. Gladys Stott who was awarded a Certificate of Merit from the Canadian Government Standards Board.

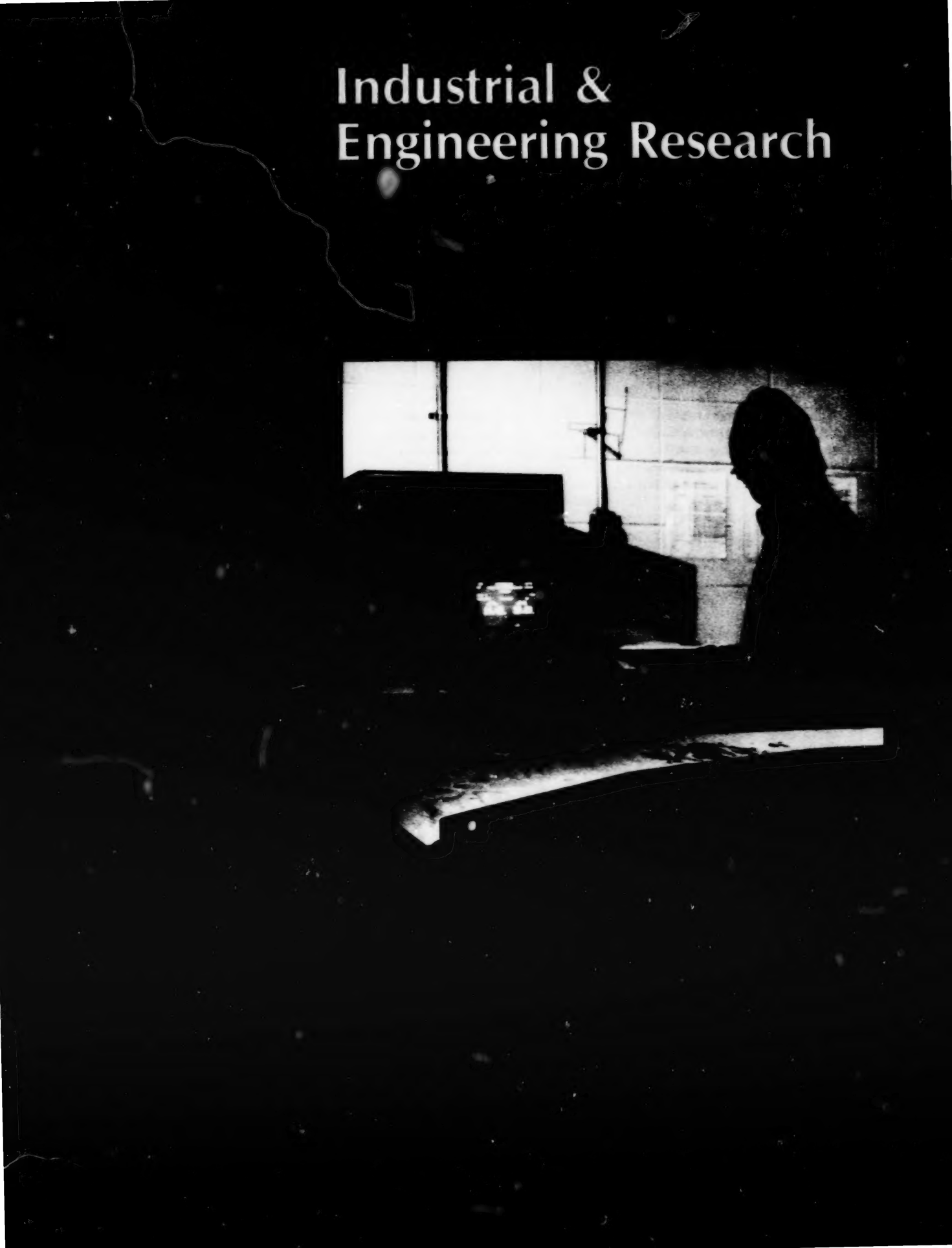
We were saddened by the death of two of our employees during the year: Mr. Alex Anderson, a highly dedicated and experienced engineer who had given excellent service to the Research Council for 26 years, and Mrs. Jane Ballash, who had managed the Coal Technology Information Center for the last several years.

I have presented the significant corporate events and decisions that took place under the Presidency of Dr. Gilles G. Cloutier and during my interim position as Deputy President since the end of August. Before concluding this report, however, I would like to accord to Gilles Cloutier the recognition that he deserves from the Alberta Research Council for the very significant contributions that he has made and which have inestimably improved the Research Council's effectiveness in being able to respond to the needs of the province. At the end of August Dr. Cloutier had completed a five-year term as President, and left to become Executive Vice-President of Technology and International Affairs at Hydro-Quebec in Montreal. He has left with the Research Council an effective management structure and a much better trained and aware management team. Also, as a consequence of his leadership in developing the Long Range Plan, we have a far more productive and effective research system, and research programs with clearly defined objectives and with specific relationships to the Alberta economy.

On behalf of the staff I thank Gilles Cloutier for giving so much of himself to the Research Council and for making us aware of the new challenges and opportunities that I trust we will be able to carry to fruition to assist the economic growth of Alberta.

R. Green
Deputy President

Industrial & Engineering Research



One mission of the Alberta Research Council is to conduct research in support of the province's economic development, particularly industrial development. In response to that mission, the Industrial and Engineering Research Program interfaces directly and mainly with industry.

The Program Development Group is responsible for coordinating many of the business arrangements in research and development for the Alberta Research Council and also is responsible for planning in the Industrial and Engineering Research Division.

The staff in Industrial Development provide advice or information on short-term projects, but client's problems calling for a larger commitment of the Alberta Research Council's resources are reviewed by the Business Development Committee, which decides where and how they should be allocated.

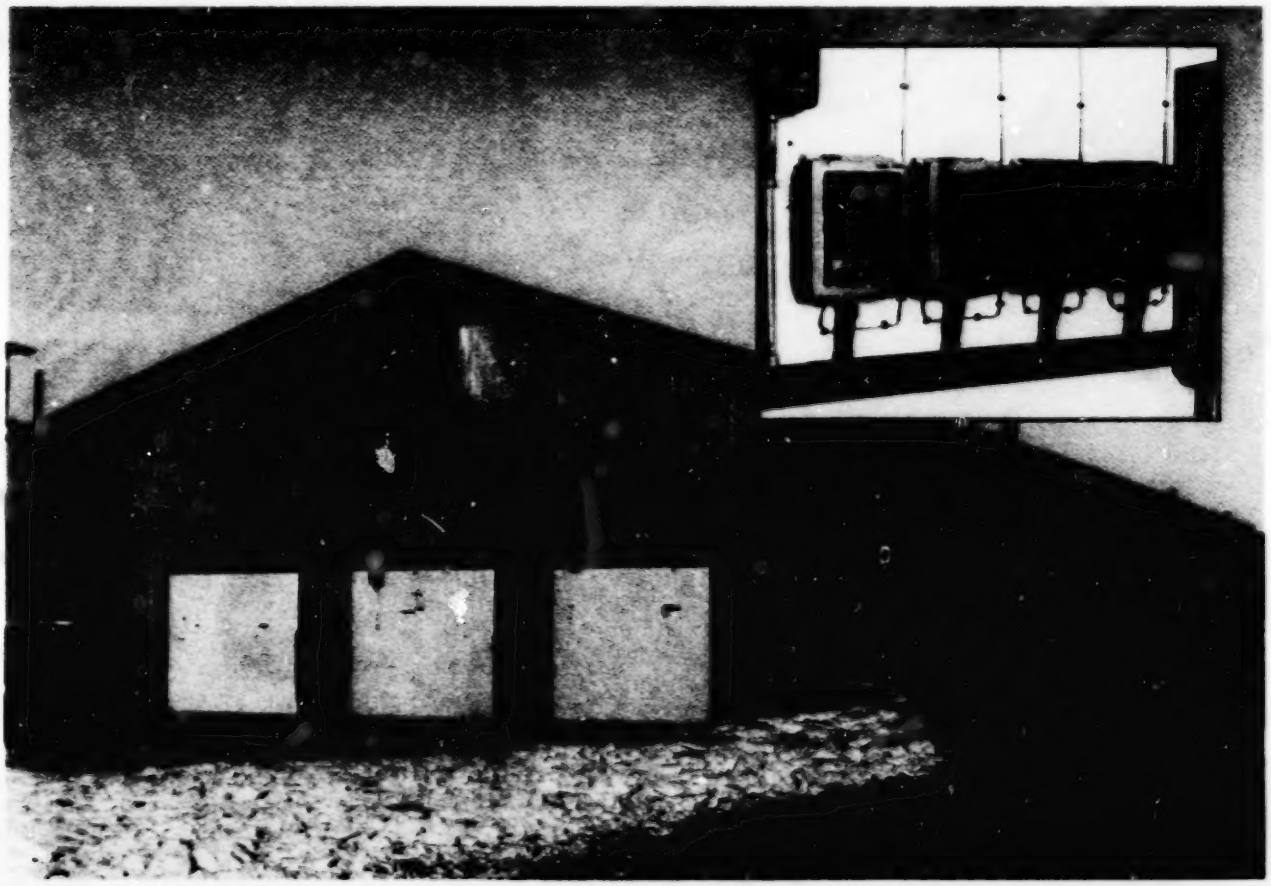
In January, the Alberta Research Council announced a pilot project by inviting Alberta companies to pursue their own high technology research projects in cooperative joint research arrangements, using the Alberta Research Council's facilities and experience in research and development. The offer included equal funding of each project accepted up to a total of $500,000 each per year for periods of up to two years with option for renewal. It also said the Alberta Research Council would share in licensing of technology, but would not wish to take an equity position in any firm.

The response to this pilot project offer was better than expected, with over 30 substantial proposals received in the advanced technologies and computing fields. Consequently, the Alberta Research Council has been unable to respond to all of these proposals, because the funds available for the pilot project were limited.

The first firm accepted under this offer was Nortech Surveys (Canada) Inc., of Calgary, which signed a two-year, $1.6 million joint research agreement. The project will be to develop a computer-based navigational system for small fixed-wing aircraft to provide navigational accuracy in aerial survey work.

A second firm to benefit from the offer was INTERA Environmental Consultants Ltd., of Calgary. The joint research agreement, signed in December, was for $1.2 million over 32 months to develop a data processing system for an advanced remote sensing radar which will be able to provide information about ice movement for oil drilling operations in the Canadian Arctic and information for other marine surveillance.

With the encouragement of industry, the Alberta Research Council established a Microelectronics Steering Committee to evaluate opportunities for Alberta in the field of microelectronics. The Committee



The Alberta Research Council assisted in the design of an environmental control system for agricultural buildings developed by Custom Electronics Services Ltd., of Lethbridge. The company is successfully marketing this system which is an improvement over foreign imports.

represented industry, universities and government. A key recommendation in its report, based on a 10-month study, was that Alberta establish a Microelectronics Chip Design and Fabrication Center to support industry in the province. The proposal is for industry to maintain, and even increase, its competitive edge on international markets in the province's areas of strength, such as petroleum, agriculture, medicine, education and their spin-off technologies which could attract new industry. Since that announcement in August, a business plan has been in development with Alberta Economic Development.

To understand better Alberta's potentials in the application of microelectronics to industry, the Alberta Research Council took the initiative to set up a task force on the Man/Computer/Machine Interface. The efforts of this task force have enabled the Alberta Research Council to plan strategy which would respond to future initiatives of high technology in support of industry in Alberta.

Industrial Development

The staff of the Industrial Development Department is responsible for publicizing services and capabilities, for solving short-term problems, for supplying technical assistance and technical information, and for putting Alberta's small industrial entrepreneurs in contact with those parts of the Alberta Research Council most able to assist them.

The staff provides industrial assistance over the short term — from an hour to several days. This service includes technical and engineering assistance with industrial problems, assistance in applying for grants through the National Research Council's Industrial Research Assistance Program (IRAP), access to computerized information systems, and advice on procedures for standardizing or certifying a product.

The industrial assistance covers many types of activities and problems. The following are a few selected examples.

In the Lethbridge area, Custom Electronics Services Limited has developed an environmental control system for agricultural buildings, an improvement over foreign imports. The Alberta Research Council assisted in the design of the system and coordinated a grant through the Industrial Research Assistance Program to retain an electronics programmer for the project. The company is now successfully marketing this system.

Great Western Garment Inc. (G.W.G.) received advice from the Alberta Research Council which allowed the company to build a prototype air flotation table. The table is for cutting material for clothing in bulk, at a cost far less than that for imported models and resulting in greater productivity.

Computer software routines have been developed to assist Alberta industry with cost analysis and cash flow projections, resulting in considerable time savings. With the use of this system and with financial advice to the business from a professional accounting firm, the Alberta Research Council can now provide better assistance in planning of product lines.

Another example of the Alberta Research Council's support of industry was advice given to Great Western Garment Inc. (G.W.G.). The company had been looking for air flotation tables for cutting clothing materials in bu". Imported models were available, but did not meet their needs and cost $120,000. The Alberta Research Council recommended materials and parts with which G.W.G. could develop its own air flotation cutting table. G.W.G. was able to build a prototype for only $15,000, and has been able to double its productivity as a result.

Rising prices for natural gas have forced an Alberta peat drying plant, the largest in North America, to consider a more fuel-efficient drying process. Researchers connected a microprocessor to a moisture analyzer — a new application in the peat industry — so that the use of natural gas is minimized in producing a given moisture level in the peat.

The Alberta Research Council represents the Industrial Research Assistance Program (IRAP) in the province, and this year it experienced a substantial increase in demand. IRAP-H ("H" being the IRAP program involving student projects) doubled from 1982 its placement of students in industry to help solve technical problems. Part of the increase is due to a change — through a cooperative program at the University of Alberta, students in mechanical, electrical and petroleum fields are now available on a year-round basis for technical assistance, instead of in the summer only.

Other IRAP programs — IRAP-M contributions for small research projects, IRAP-L for contributions to laboratory investigations and IRAP-P contributions for major research projects — have also shown increases over 1982.

Materials and Processes

The Alberta Research Council can carry out a wide variety of physical and chemical tests on materials and products to help Alberta manufacturers solve their problems.

Instead of operating a processing plant for bitumen at each mining or in situ extraction site, companies recovering bitumen from oil sands transport the bitumen by pipeline to central processing plants. To reduce its viscosity sufficiently for this transportation, the bitumen is often diluted with lighter hydrocarbons, but in some areas of Alberta these lighter hydrocarbons are not readily available. An alternative method is to transport the bitumen by pipeline as

an oil-in-water emulsion. The Alberta Research Council has conducted a feasibility study with a small laboratory scale pipeline, and has measured pressure differentials during the pumping of these emulsions. The results obtained will assist in the technical assessment of the concept and the projection of energy costs for pumping different concentrations of oil-in-water emulsions.

New applications have been developed from a membrane process developed at the Alberta Research Council to separate helium from natural gas. The process has been applied successfully in laboratory experiments to the separation of hydrogen out of purge gas from ammonia plants or petrochemical plant recycle gas. Laboratory testing is complete and the concept is ready for pilot plant testing. Laboratory investigations indicate the membrane process can also be used for "sweetening" sour natural gas. The conventional sweetening process of removing carbon dioxide and hydrogen sulfide from natural gas through absorption by solvents is costly. By combining the membrane process with the solvent absorption process, the cost of removing hydrogen sulfide and carbon dioxide can be reduced by 50 percent. This hybrid process must now be tested in a pilot plant.

In response to the increased demand from industry for physical and chemical testing of plastics, particularly sheeting and film, the Alberta Research Council has increased its plastics testing capability. An ambient temperature chamber, a low temperature chamber and a high temperature chamber have been installed. A state-of-the-art differential scanning calorimeter with sub-ambient capabilities, a gas chromatograph and a high pressure liquid chromatograph have been installed and are now in operation for chemical evaluation of plastic materials.

Forest Products

The Alberta Research Council, supported by Alberta Energy and Natural Resources and Alberta Economic Development, conducts research, development and testing of forest products. It also responds directly to requests from industry on forest products research. The aims of this research program are to provide quality control and increased yields for more effective processing of wood, to develop new products from Alberta aspen wood, and to provide more effective use of Alberta forest products.

A major strength of the Alberta forest products industry is panel products manufacturing. There is no "commercially proven" on-line, automated stress rating system for panels available in North America. The Alberta Research Council has developed a prototype on-line machine to perform stiffness ratings for panel products, and to replace manual inspection and grading of finished products. Results of tests performed with this machine are encouraging, and a second prototype is planned in continued cooperation with the forest products industry to further test the feasibility of the system.

A feasibility study by Woodbridge, Reed and Associates Ltd., for the Alberta Research Council, indicated fungal decay of aspen had limited impact on the production, quality and cost of special high-yield pulp from typical qualities of Alberta aspen. The study indicated that it is technically and economically feasible to produce this high-yield pulp. This Alberta Research Council study has confirmed that, with its large reserves of aspen, Alberta could provide attractive resources for pulping companies in the years ahead.

Systems Engineering

The Systems Engineering Subprogram includes research in transportation, geotechnical and structural engineering.

The considerable changes in the designs and numbers of automobiles, trucks and recreational vehicles in recent years have changed the demands on Alberta's two-lane highways. A project at the Alberta Research Council assists Alberta Transportation in understanding and quantifying the effects of these changes on highway traffic operations. Traffic data, such as numbers, speeds and spacing of vehicles, are being collected using a mini-computer mounted in a mobile laboratory van. The behavior of drivers while passing on highways is being measured using custom-built microprocessor units. The project is to aid the updating of highway design standards and to assess the feasibility of alternatives to major highway upgrading, such as the provision of passing lanes.

Calculation of forces from measured vibrations due to ice movement have been made on large bridge piers. The Alberta Research Council has conducted studies on the use of this technique for smaller bridge piers, to avoid the high cost of direct ice force measurement and to improve design guidelines for bridges on small rivers.

Energy Supply

With rising energy costs and growing concern over farmland lost because of poor drainage and high soil salinity, the Alberta Research Council developed a project with Alberta Agriculture to evaluate the potential of modern wind turbines in pumping irrigation drainage water, the performance of wind turbines operating in Alberta's climate, and to demonstrate the capabilities of various types of wind turbines for other possible applications by farmers and irrigation managers. The project — part of the Solar and Wind Energy Research Program (SWERP) — is a field demonstration on a test site northeast of Lethbridge. Six wind turbines were installed to pump water continuously while being monitored for wind energy performance employing computerized data acquisition methods.

In Canada's north, where other fuels — solar energy, bio-fuels from trees, hydro — are impractical, there is a growing awareness that wind is a viable energy source. As a cooperative venture with the Alberta Forest Service, and the federal Atmospheric Environment Service's Arctic Weather Center, the Alberta Research Council developed computer programs and computer graphics to process large volumes of climatological data for the purpose of wind energy and power analysis. This study resulted in a publication by the Science Advisory Board of the Northwest Territories, entitled "Wind Energy in the Northwest Territories" authored jointly by the three sponsoring agencies. The capabilities developed for this study were applied to process 10-year wind data records from 143 Atmospheric Environment Service stations across Canada for a nation-wide wind energy assessment.

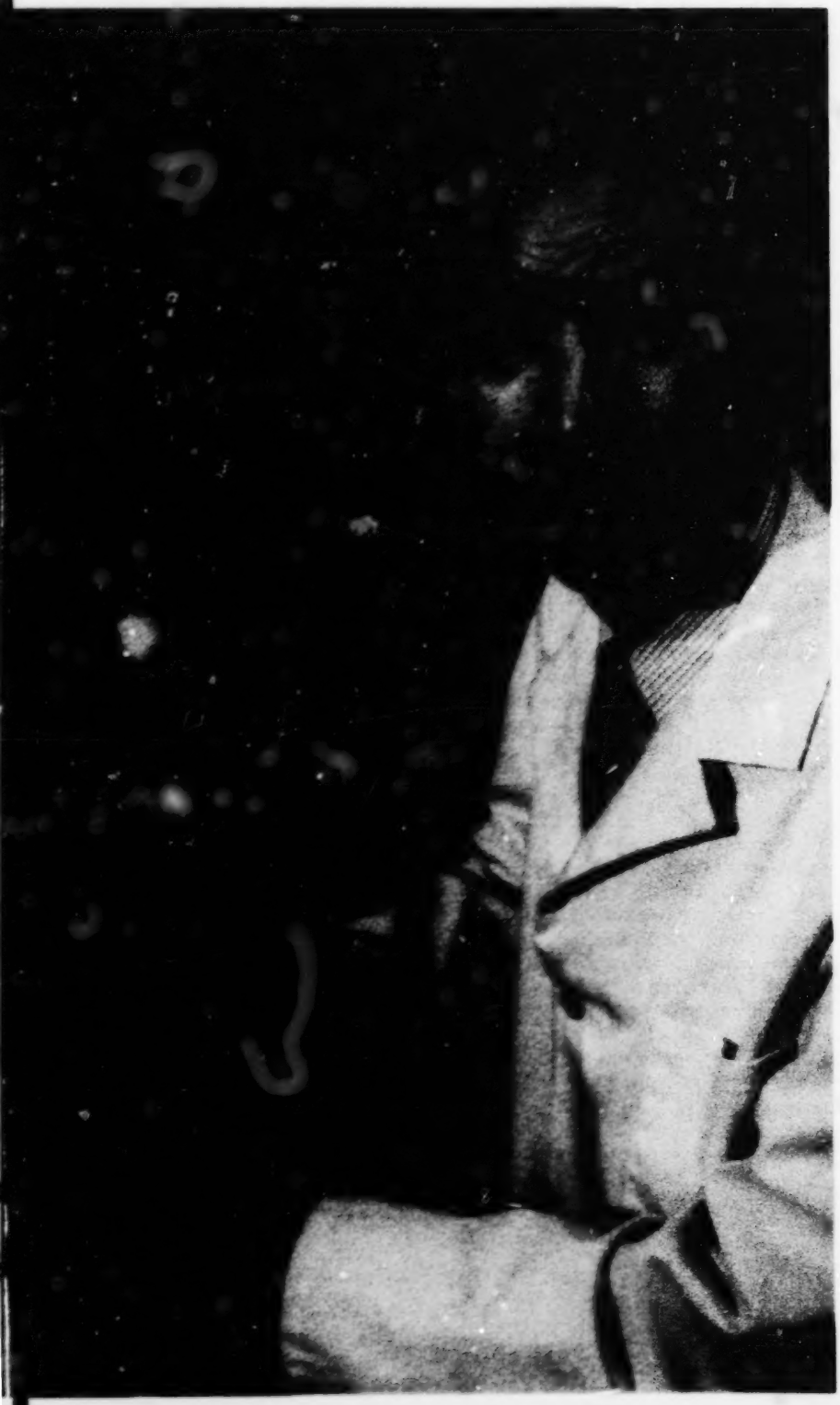
The Frontier Sciences research includes new fields considered to offer long term economic opportunity for Alberta. They are among the fastest growing areas of scientific research, and include hydrocarbon research, biotechnology and applied computing science.

Hydrocarbon Research

Needs and opportunities in hydrocarbon research are being reviewed: research would concentrate on investigating novel processes for conversion of bitumen, heavy oils and coal liquids into useful transportation fuels. Research in this area will supplement and support that in coal and oil sands research. The production of petrochemical feedstocks from these materials also will be evaluated for their potential opportunity.

The work to date has largely been exploratory to define specific lines of approach. One activity concerns building small molecules into useful liquid fuels. It will involve further development of soluble hydroformylation catalysts already prepared at the Alberta Research Council. Catalysts, based on metal clusters, will be synthesized for the conversion of carbon monoxide and hydrogen into useful fuels.

New processes for converting bitumen, heavy oils and coal liquids into useful transportation fuels are the basis of hydrocarbon research now underway.



Biotechnology

Research activities in biology have been restructured to maximize the possibilities for interaction with the present and future economy of Alberta in the following three areas: pharmaceuticals and specialty chemicals; agriculture; and biotechnological equipment manufacture.

The joint research venture with BIO LOGICALS inc. caused health care-related research in genetic engineering to be introduced to the Alberta Research Council. Genetic engineering research under the joint research venture will contribute to the development of pharmaceuticals and specialty chemicals. Researchers in the project laboratories have successfully introduced synthetic DNA into bacterial systems. Based on previous experience of computer programming in support of research, a computer program was developed for DNA sequence analysis.

In another area of biotechnology research, the Alberta Research Council is investigating the considerable process development required to bring a genetically engineered product into production. To facilitate the scale-up of biotechnological processes, a pilot plant project will make

Left Biotechnology research at the Alberta Research Council includes projects in low temperature microbiology, working towards developing frost tolerant crops for Alberta. Dr. Toshi Kaneda is shown examining bacterial cultures.

Right Alfalfa plants are tested individually for nodulation — the formation of lumps at the roots — by the nitrogen-fixing bacterium, Rhizobium.

full use of computerized process control technologies, and another project will concentrate on developing process equipment which could be manufactured in Alberta.

To address the critical factor of low temperature's effect on agriculture in Alberta, biotechnology research includes two projects in low temperature microbiology: the fundamental mechanisms of cold tolerance; the practical problem of developing cold and frost tolerant nitrogen-fixing bacteria which are compatible with alfalfa, an important forage crop in the province. If researchers are successful, their findings could be developed further in conjunction with other Alberta Research Council groups involved in genetic engineering and biochemical engineering pilot plant operations.

Another project, in progress with Alberta Agriculture, is to isolate and study the bacteria which lead to the freezing of crops — particularly rapeseed and beans — under frost conditions.

Applied Computing Science

In the last decade, advances in the area of artificial intelligence have spawned a new subfield of research and development known as "expert" or "knowledge-based" systems. These systems are designed to represent, and operate upon, knowledge in particular domains to solve complex real-world problems which otherwise would require considerable human expertise, training, and experience. Systems that solve problems in domains as diverse as molecular structure identification using mass spectrometer data, medical diagnosis, and oil and mineral exploration have performed as well as the human experts who worked with computing scientists to design them.

The power of this technology lies in its potential to duplicate human expertise, a commodity that can be expensive, unavailable, or take years to acquire. Its aim is to produce intelligent systems serving as consultants and assistants in a complementary role with human experts where they exist, and providing knowledge and advice where human experts are unavailable.

The Alberta Research Council has acquired some initial software and hardware facilities for developing knowledge-based systems and for investigating the longer-term issues in this applied field. Problems in several domains, such as environmental data interpretation and medical science, are being considered for development using artificial intelligence tools and techniques. A significant expansion of research activities in expert systems, distributed systems and software development environments is planned.

Special Project

Under Alberta Agriculture's research program "Making the Most of Nitrogen," the Alberta Research Council has contributed to an understanding of the effective use of nitrogen fertilizers. The initial project, to develop agents to prevent the bacterial conversion of ammonia to nitrate in the soil, has been terminated since the inhibitors did not perform well in the field.

Nitrogen fertilizers applied in the fall are largely lost from surface soil before spring planting. Some evidence suggests that this loss is due to the escape of nitrogen gas to the atmosphere, but leaching has been shown to be a major factor in some circumstances. Since nitrogen uptake by crops is the ultimate test of the efficient use of fertilizer, studies have been carried out to measure the uptake of nitrogen at various stages of plant growth.

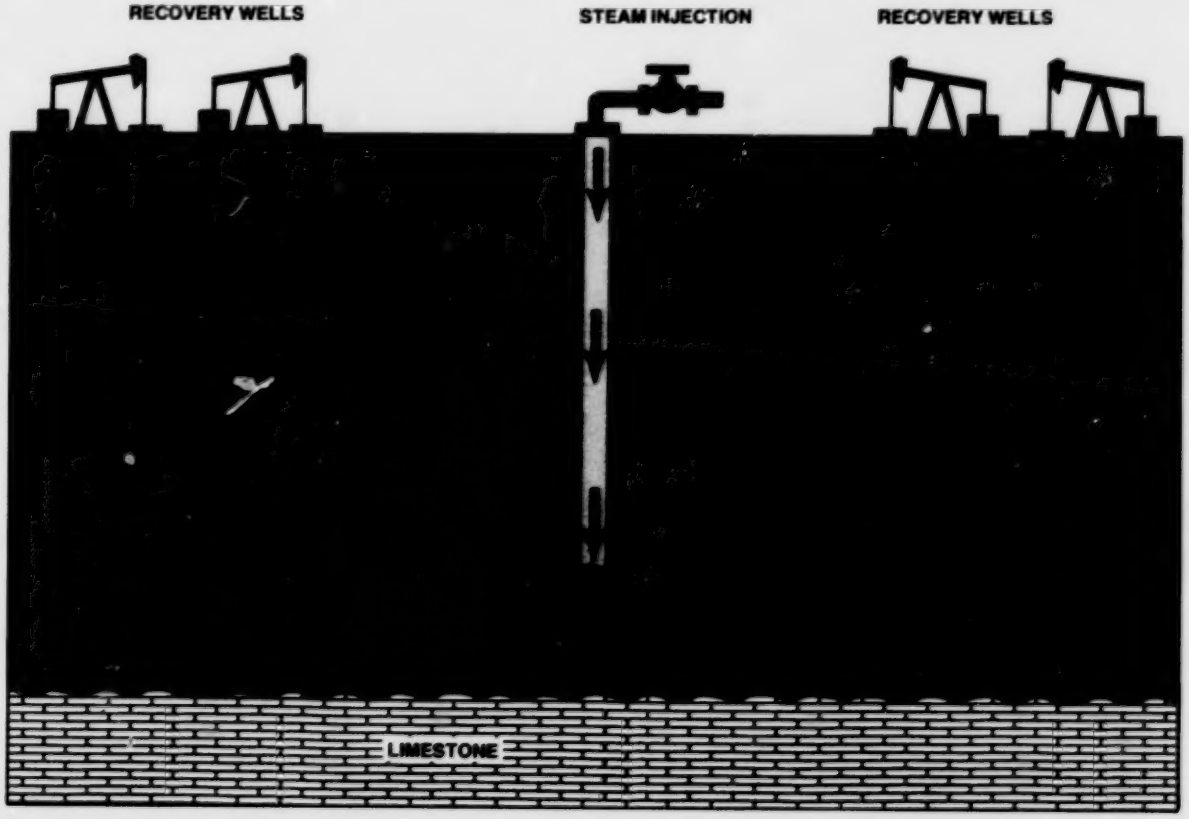
It has been found that the later fertilizer is applied, the more fertilizer is found in the crop. In addition, nitrogen, placed near the roots for maximum penetration into the plants, is very efficiently utilized by the crop. This observation implies that supplemental nitrogen provided to the plant in the later stages of growth can compensate for the leaching of fertilizers in the spring.

The Alberta oil sands deposits are among the largest hydrocarbon deposits in the world and must play a major role in Canada's future energy production. Two commercial enterprises, Suncor Inc. and Syncrude Canada Ltd., are using very large scale mining technology and a bitumen extraction process previously developed by the Alberta Research Council to extract the viscous bitumen from oil sands deposits near the surface for refining into fuel. Although the technology for these surface mining techniques is now well developed, surface deposits comprise only 10 percent of the total estimated reserves. The Alberta Research Council's program, therefore, is focussed on developing a new technology so that bitumen can be recovered directly from the 90 percent of the oil sand reserves lying 50 to 800 metres underground.

The basic problem is to develop a technology for separating the bitumen from the sand deep underground and moving it to the surface. At low underground temperatures the bitumen is so viscous that it acts more like a solid than a liquid. It must be heated, or mixed with solvents to reduce its viscosity, to allow it to flow through the porous spaces between the sand grains. In conventional oil deposits there is usually sufficient pressure to move oil through the deposit to the recovery well. Oil sands deposits, however, have very little fluid pressure. Once the viscosity is reduced, fluids must be injected into the deposit to force the bitumen to flow. The hot fluids injected into the deposits can react with the rock to hinder, or assist, the movement of the bitumen. Finally, the successful development of an in situ recovery process requires a detailed understanding of the deposits' geological features.

To reduce the viscosity of bitumen enough that it will flow to a recovery well, steam is injected into an oil sand formation. This process, however, is not efficient in reaching the whole formation and therefore leaves much of the bitumen behind. For that reason, additives such as gases, solvents, or surfactants have been introduced and tested. Little is known about the physical properties of these additives under high temperature and pressure conditions. Under laboratory conditions surfactants have proven very efficient when injected with steam, but only for short periods of eight to nine hours. In the field, however, surfactants must survive a matter of months. Researchers have developed a stabilizer to retard the chemical decomposition of these surfactants, keeping them active for the required time. This process is ready for field trials and is under consideration for a patent.

Another problem faced in the underground recovery of bitumen



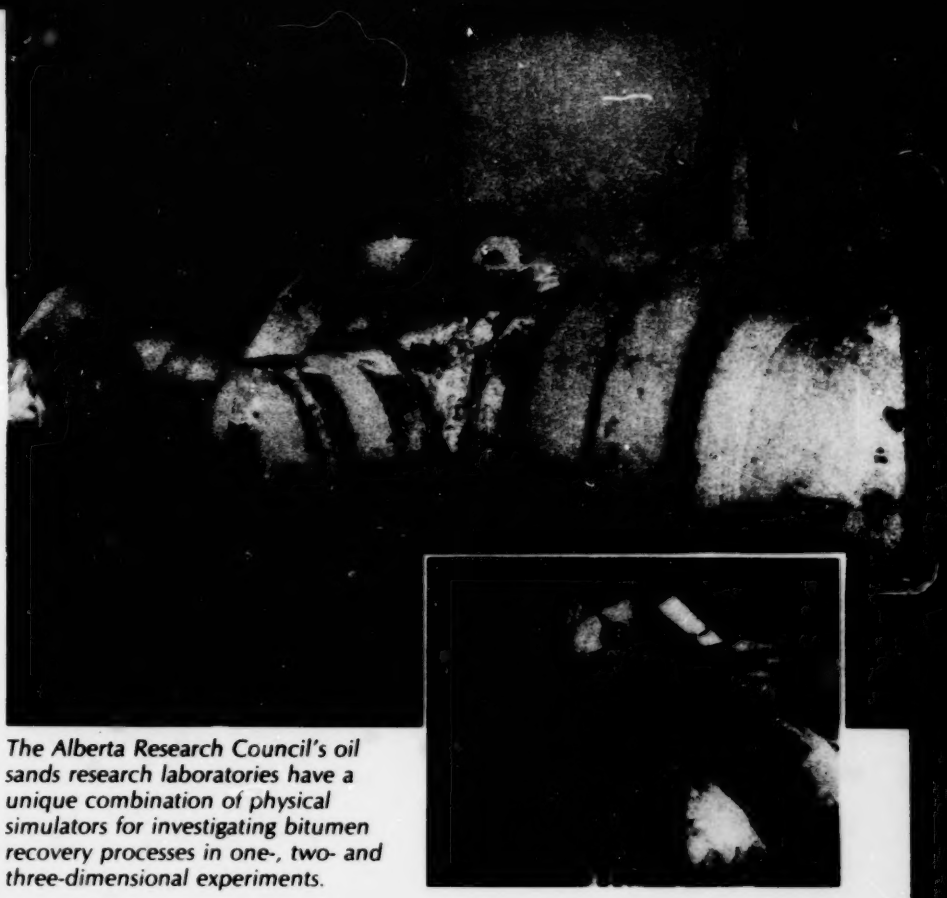
Ninety percent of the estimated reseves of oil sands in Alberta lie up to 800 metres underground. A comprehensive range of research projects at the Alberta Research Council is dedicated to developing effective, yet economical, in situ bitumen recovery processes.

from oil sands is the stabilizing of the thin film of water around each grain of sand. Without that water, the bitumen would stick to the sand. The Alberta Research Council recently developed a theory for analyzing the stability of this layer and explaining other forces acting at this interface. Based on that theory an improvement to a caustic flood process has been outlined and is being considered for a patent.

This bitumen-water-sand interface is also an area of fundamental research which concerns changes in the chemistry and the water layer of the injected fluids with the increase in temperature in an oil sand formation. Researchers are studying the chemistry and thermodynamics of aqueous solutions up to 300°C and are attempting to develop mathematical models of various processes with this information. Data already exist on these dynamics at low temperatures less than 100°C, but researchers must develop a framework to be able to use low temperature data to predict high temperature reactions. With so few measurements at high temperatures it is difficult to confirm the predictions of the mathematical models. The Alberta Research Council has established a world class thermochemistry laboratory to use the great wealth of available low temperature data for describing high temperature reactions which occur in a steam covered process.

Numerical models are used to predict how a new process will perform in the field. In the past, numerical models of bitumen recovery processes have been limited to two basic components — steam and bitumen. To make this numerical modelling more useful in predicting field performance, the numerical model has been expanded to four components, such as steam, bitumen, gas (methane or ethane) and liquid hydrocarbon. The first test in applying this four-component model was a field study for an AOSTRA field pilot project. Predictions have proven to be accurate and have been useful in guiding field work.

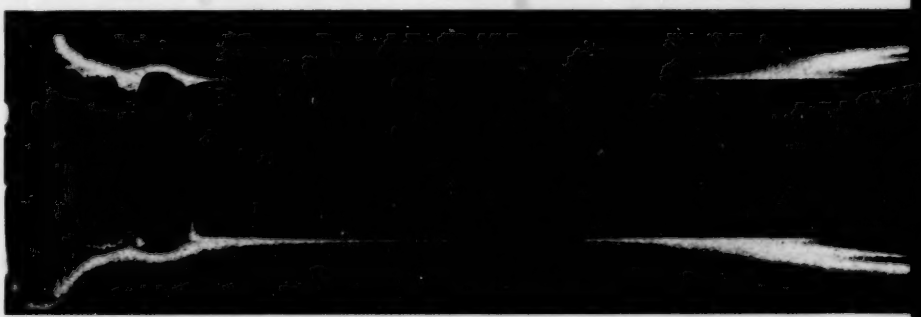
The Alberta Research Council has established a parameters laboratory for developing mathematical equations on which mathematical models are based. The four parameters under consideration in the lab are viscosity, diffusion of injected gases in an oil sand reservoir, relative permeability of fluids flowing through a reservoir, and phase equilibrium relationships of the reservoir fluid and additives and how they react with each other. This parameters laboratory has produced significant data for modelling in the area of viscosity and diffusion.



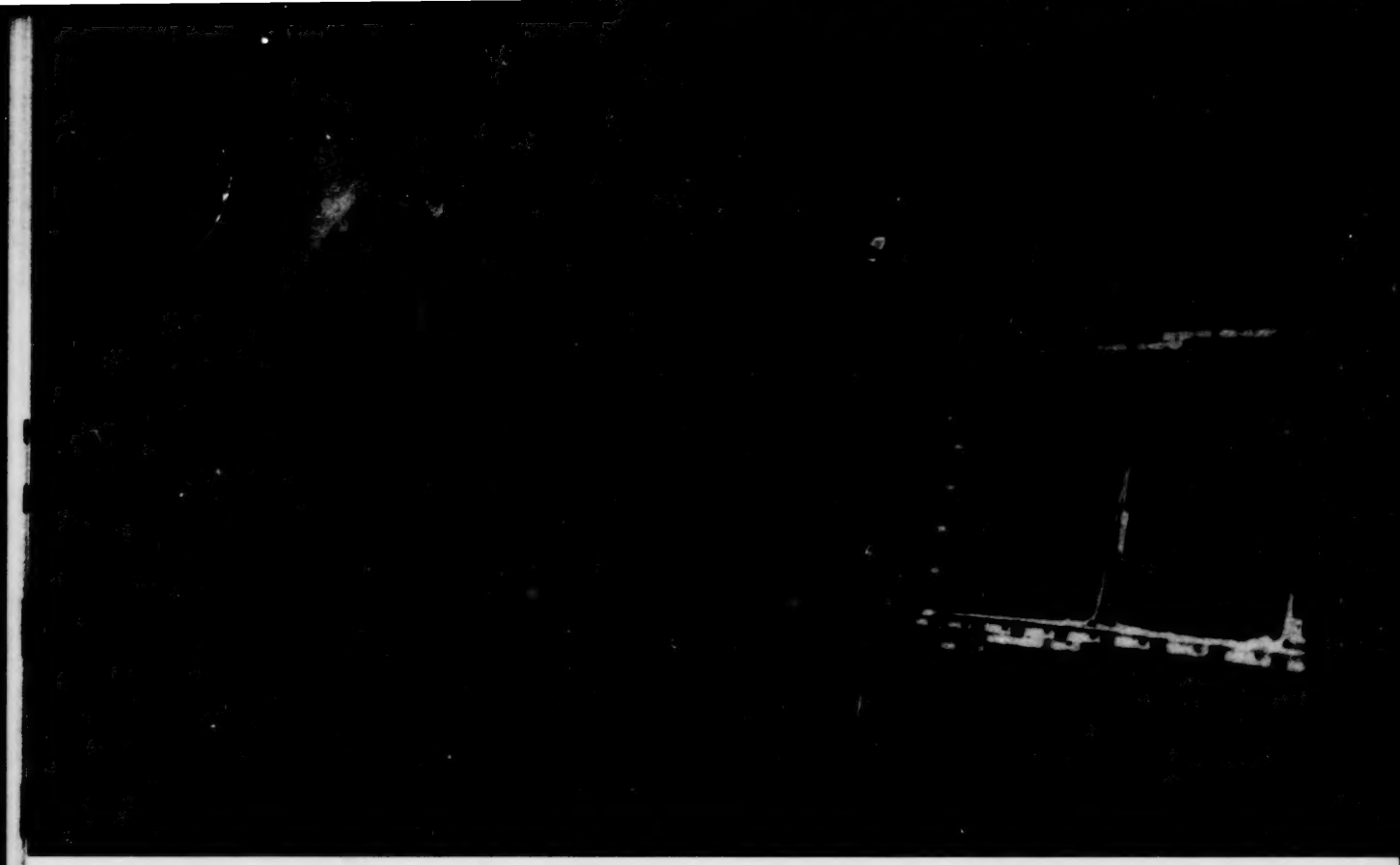
The Alberta Research Council's oil sands research laboratories have a unique combination of physical simulators for investigating bitumen recovery processes in one-, two- and three-dimensional experiments.

Researchers have been studying the relative amount of oil and water in an oil sand formation in order to understand better the flow of fluids through the formation during a given recovery process experiment. To follow changes in oil and water content during a trial, they have examined various possible techniques and narrowed the most effective technique to x-rays or gamma rays. Using a single beam shot through a core of oil sands, researchers can measure the relative amount of oil and water along that beam. By rotating that beam through many positions researchers can further determine how much bitumen or water there is in a formation and where each component is, thus contributing to an understanding of the recovery process.

A problem associated with recovery of bitumen is that sand



Using x-rays, researchers now can follow visually the changes as water, flowing from the left, displaces oil during the test of a bitumen recovery process.



An analytical chemist examines the properties of bitumen and bitumen recovery process fluids using a variety of instruments, including Fourier Transform Infrared Spectroscopy.

grains from the formation tend to plug recovery wells or erode production equipment. Researchers have developed, under contract for Texaco Canada Resources Ltd., a novel sand exclusion system which is now being evaluated in field trials. This technology is the property of Texaco and the system can be fabricated by companies in Alberta.

The Oil Sands Sample Bank increased its volume of shipments in 1983 by 8.5 percent, shipping 106 tonnes of oil sands samples to various petroleum research laboratories in the world. As part of a continuing program, it also received and characterized oil sands samples from Zaire, Sicily, New Mexico and California. Also in the Oil Sands Sample Bank project, researchers completed the second year of a three-year study to determine the optimum conditions of oil sands storage. Earlier results have been confirmed that oil sands must be frozen at $-10°C$ to prevent aging. Tests also indicate that freezing has no impact on the effectiveness of hot water extraction processes.

During 1983, geologists continued their regional scale investigation of all of the major oil sand and heavy oil deposits in the province. In addition, they completed site-specific studies relating to the Alberta Energy Company in-situ pilot plant at Suffield, the new Amoco pilot plant in the Athabasca Deposit, and a number of other possible pilot sites in both Cold Lake and Athabasca. Site selection work was completed for the Underground Test Facility being developed by the Alberta Oil Sands Technology and Research Authority (AOSTRA).

Researchers continue to provide valuable geological insight into the operation of specific field pilot plants, through involvement in AOSTRA/industry Technical Advisory Committees. In the international arena, a study of the Sao Paulo State oil sand occurrences, Brazil, was completed for AOSTRA and Paulipetro, the government petroleum agency in Brazil.

Alberta has about 80 percent of Canada's known coal reserves, which amount to at least as much energy content as all known reserves of oil sands and heavy oil in the province. The extent, quality, and availability of coal reserves underneath the Alberta plains makes coal a major source of liquid fuel to meet the energy demands of future years. Coal can be converted to many products such as fuel gas and synthesis gas for hydrogen and ammonia production, but liquid fuels remain the most attractive because they can be transported cheaply over long distances. The high energy density of liquid fuels also makes them uniquely suitable as fuels for transportation and agriculture. Furthermore, projected long-term increases in oil prices, Canada's desire to become self-sufficient in energy, and efficient coal conversion technology of the kind the Alberta Research Council is investigating could make coal economically competitive as a future source of synthetic fluids.

Considerable information about European, Eastern American, Japanese and Australian coals is already available. Western Canadian coals, however, are different in physical and chemical structure and geological origin. Since coal conversion processes depend on the characteristics of the feed coals, the Alberta Research Council is investigating coal conversion technologies suited to local coal characteristics and production capabilities. It also is investigating the geological characteristics of the coal deposits themselves. This research is funded jointly by the Alberta Research Council and the Alberta/Canada Energy Resources Research Fund.

Early in 1983, the last of the large containment cells arrived and were installed at the Alberta Research Council's interim high pressure facility in Nisku, allowing this facility to reach full operation during the year.

To date, seven Alberta subbituminous coals have been evaluated in five liquefaction processes using batch autoclaves. The results have enabled researchers to rank coals according to reactivity and selection of the most promising process conditions. Coals from the Battle River and Pickardville areas proved to be more reactive than coal from Fox Creek and South Swan Hills while coals from the Ardley and Wabamun areas were the least reactive for the process conditions tested. Mean conversion reactivities reported on a dry ash free basis ranged from 80 percent to 97 percent. Furthermore, the results indicated that processes using dispersed molybdate as the catalyst gave the best results with all coals tested both in terms of amount of coal converted and the yield of distillable oils.

Another process particularly relevant to Alberta conditions coprocessed coal and bitumen in two stages using carbon monoxide in the first stage and hydrogen in the second stage. Since ash content of the mined coal is detrimental to conversion, the Alberta Research Council, supported by Alberta Energy and

The interim high pressure facility for coal research, in Nisku, reached full operation early in 1983 with the installation of the last of the large explosion containment cells. These cells and other features contribute to the high standard of safety maintained in coal research.

Natural Resources, investigated beneficiation by agglomerating the coal with small amounts of heavy oil added to a pipeline transporting coal-water slurries. The agglomerates formed in the pipeline could be separated easily from the water and mineral matter by a simple sieving operation. Research has shown that high quality agglomerates are formed with both bituminous and subbituminous coals from Alberta, with little loss of fine coal in the effluent water. This process could make Alberta coal more competitive on the world market for thermal coals. In addition, liquefaction of agglomerates with low ash content in two stages should reduce the cost of synthetic oil from coal.

Two experimental units which became fully operational during the year were used to evaluate and optimize liquefaction processes. Results from the hot charge/discharge unit, a semi-continuous two-stage unit, have shown that high yields of good quality light oil are produced directly from both reactor stages at certain temperatures, and reaction times. Results from the bench unit, a continuous flow unit processing 2 kg/h of coal, have shown that under optimum process conditions the conversion of the least reactive coal from the Wabamun area can be increased from 80 percent to 90 percent.

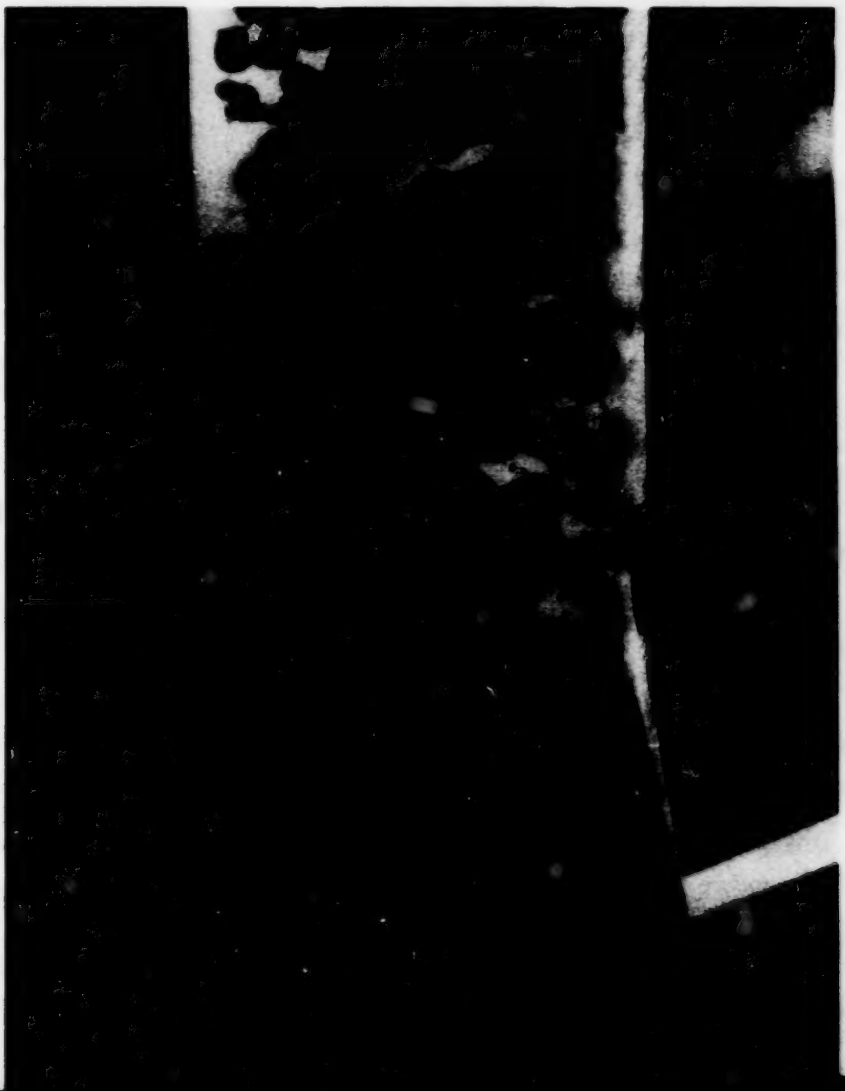
The pyrolysis behavior of six Alberta subbituminous coals was evaluated in a 5 g/h continuous flow entrained bed laboratory reactor to determine the amounts and types of char and volatile products produced at different temperatures and reaction times. The results show mean oil yields ranging from 12 to 20 percent reported on a dry ash-free basis.

The pyrolysis bench unit capable of processing 2 kg/h of coal with an inert gas, helium, and with hydrogen gas was operated successfully with Highvale, Vesta and Ardley coals.

The combustion characteristics of the char produced from different coal and at different heating rates were investigated using a thermogravimetric analyzer. Chars produced from low pressure pyrolysis in an inert atmosphere were more reactive than those produced under high pressure with hydrogen. The tar and oil products are to be examined as well to determine their quality for potential upgrading to marketable products.

Basic research in coal and process chemistry was carried out to develop a better understanding of the behavior of coal in different processes. Maceral fractions, separated from coal by density gradient centrifugation and from mineral matter by acid treatment were reacted in micro-autoclave to determine their liquefaction reactivity. The results indicated higher conversion of demineralized fractions for some coals while the reverse trend was evident for other coals. Continuing work is directed to developing a better understanding of the reactivity of different coal constituents and the role of mineral matter in determining conversion reactivity. A mathematical model was developed for liquefaction reactors which will assist in determining operating conditions for optimum liquid yields in a series of three reactors normally needed in commercial plants.

Coal geology studies are concentrated in the Alberta plains. Emphasis was on the nature and origin of coal seams at comparatively shallow depths, generally less than about 500 metres, with potential for shallow mining or in-situ conversion. This year researchers completed a five-year drilling and coring program to complement the database available from outcrop studies in the badlands along the Red Deer River. The program reached a position to finalize



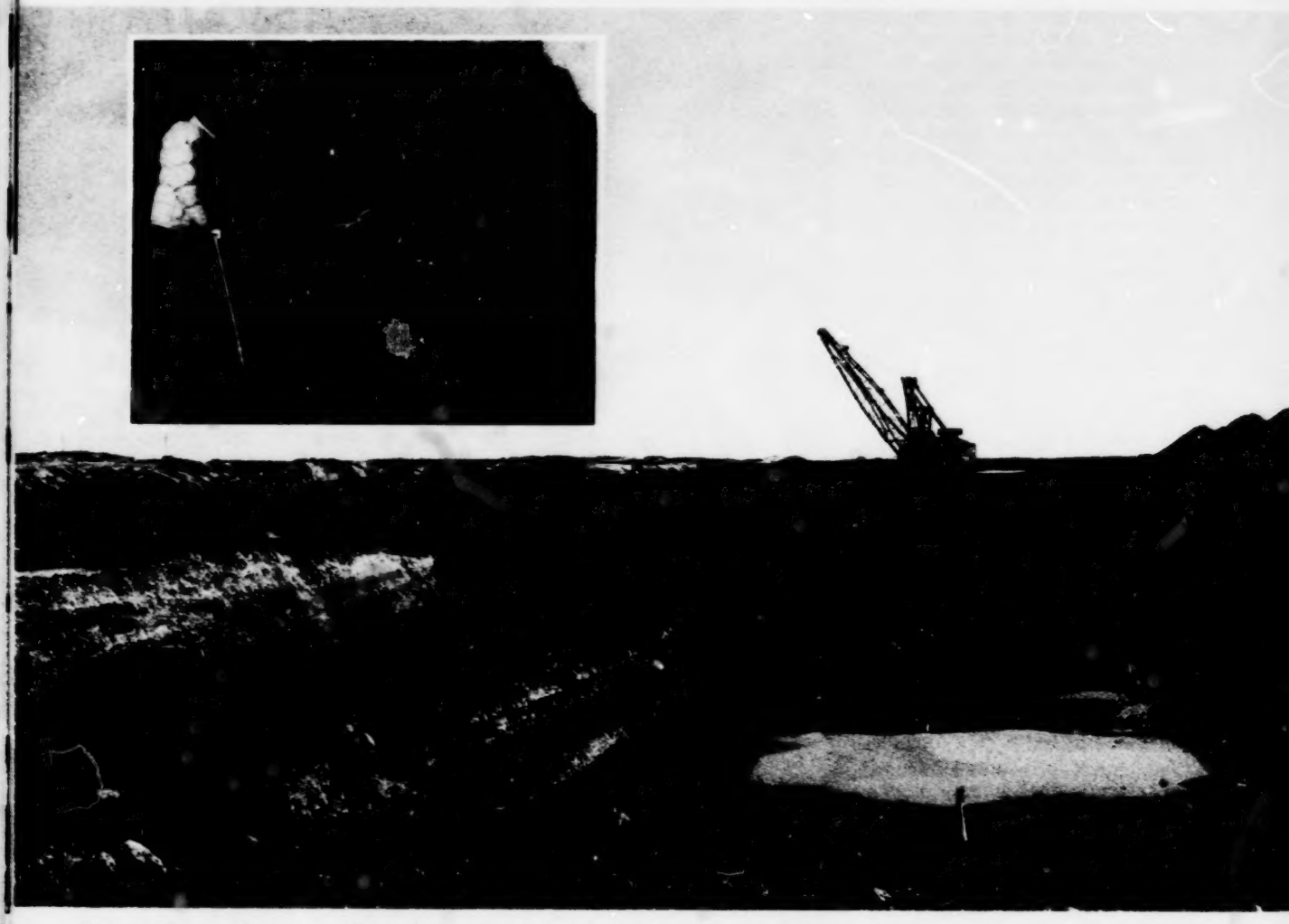
Fine coal and a small amount of oil form spherical particles when transported in a water slurry through this test pipeline. Mineral matter, which is not bound to the coal by the oil, is removed in the process. Research has concentrated on achieving the beneficiation and transportation of coal by pipeline over long distances.

which the coals were laid down some 60 to 80 million years ago. These interpretations should facilitate prediction of the thickness, continuity and quality of coal seams in the subsurface.

In the Grande Cache coal field, computer models were used to project the geometry of the economic coal seams. Smoky River Coal Limited (McIntyre Mines) started using the models to define new reserves and keep the mine open.

Serious instability of highwalls at some surface coal mines in the plains of Alberta have posed a threat to the safety of mine workers and equipment and have increased operating costs of mining the coal. This instability is caused by locally weakened overburden rock resulting from structural disturbance to depths of tens of metres, caused by glaciation during Pleistocene time. Regional mapping studies conducted by the Alberta Research Council during the past 10 years have led to a unique expertise among our geologists who can recognize the landscapes characteristic of such glacial tectonic terrain. This expertise is being applied in conjunction with an intensive program of core drilling, downhole geophysical logging, and surface geophysical studies to identify and characterize deformed terrain at the Highvale Mine south of Lake Wabamun. Data from this study will be incorporated into mine planning by varying highwall angles or pit orientation and in bench design to minimize the threat posed by the instability. The Alberta Research Council study is designed to look at other mine sites in order to permit generalization of the results across the entire plains area of the province.

A new development, with the support of the sponsoring group, Alberta Energy and Natural Resources, was a joint cooperative project with Alberta Culture and Alberta Recreation and Parks to explore the conditions in which dinosaurs lived, particularly in the Drumheller area which has Canada's heaviest concentration of dinosaur remains contained in the coal-bearing rocks of the area.



Some surface coal mines in Alberta have experienced serious instability of highwalls, threatening the safety of mine workers and equipment and increasing operating costs. The problem is caused by rock contorted by glacial deformation (inset photograph). The Alberta Research Council has advised coal mining companies on angles of highwalls and pit orientation to minimize the problem.

Natural Resources Research

Air

Hailfall damages over $100 million worth of farm crops every year in Alberta. Mainly for this reason, the Alberta Research Council is operating a five-year weather modification research project, sponsored by Alberta Agriculture and the Alberta Research Council. This was the third year of the current project, conducted in an experimental region within a 150 km radius of Red Deer. Cloud seeding operations for hail suppression were conducted from late June until the end of August, in the area between Red Deer and Calgary. The northern half of the experimental region, between Red Deer and Edmonton, was devoted to specific cloud seeding experiments.

The new research aircraft, developed with INTERA Environmental Consultants Ltd., of Calgary, has been used for making detailed measurements inside storm clouds in response to cloud seeding operations. It reached full operation in 1983, and has proven to be a major breakthrough in data gathering for the very large and complex project of research into weather modification. The aircraft has been used for cloud seeding experiments in hail suppression, and in experiments to increase rain and, in March, for assessing snow augmentation potential.

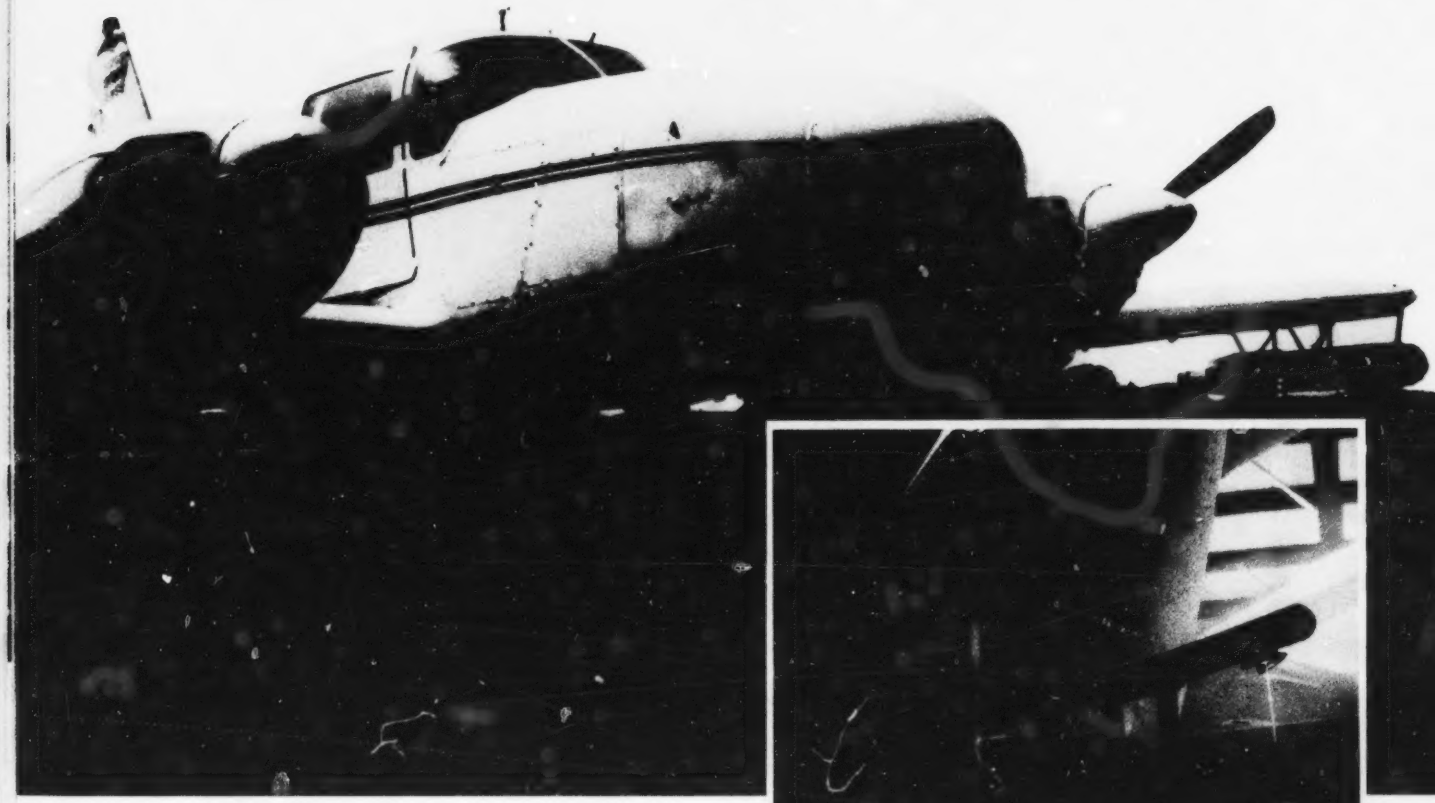
One interesting observation made with the research aircraft during the summer was the verification of seeding effects in small cumulus clouds. Using seeding agents, such as dry ice or silver iodide, researchers were able to detect a dramatic increase in the ice crystal concentration and, on several occasions, were able to see radar echoes develop along the seeding path. These results start to verify the possibility of inducing rain in small cumulus clouds.

In past years researchers have had to observe precipitation type — rain or hail — from the ground. By comparing those observations with standard weather radar measurements of precipitation in clouds researchers now have been able to develop a method of examining radar echo intensities directly above a spot on the ground to determine the probability of hail, or rain only, falling to the ground. This new technique has led to a better understanding in applying radar observations more accurately, for example, to assess crop damage by hailfall.

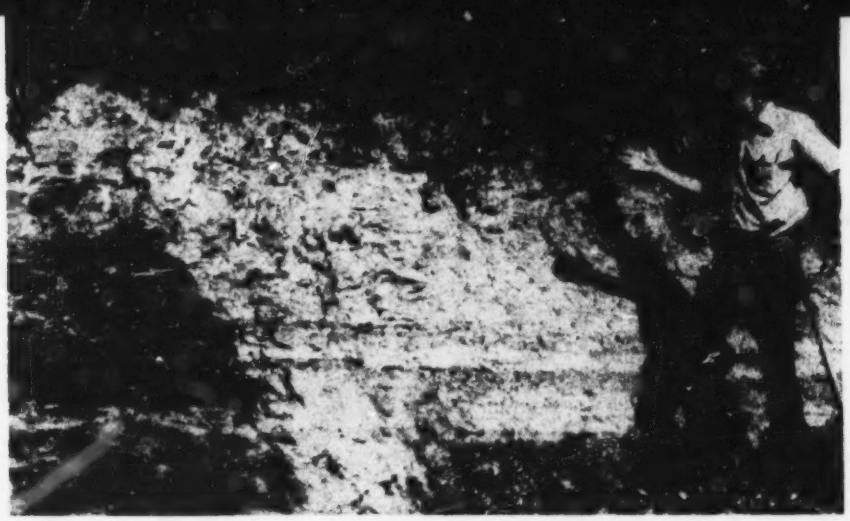
Researchers have developed a computer system for transmitting weather radar data as electronic graphics from Red Deer to Edmonton. The data can generate through the system a color display map of rainfall on a video monitor, and printed maps and tables of accumulated rainfall, for the use of Alberta Environment hydrologists. The prototype system was developed and tests for operational use will start in 1984.

The Alberta Research Council also acted as consultant to Raytheon Company, one of two companies competing to define the next generation of weather radar, in its bid to supply the system to the United States government.

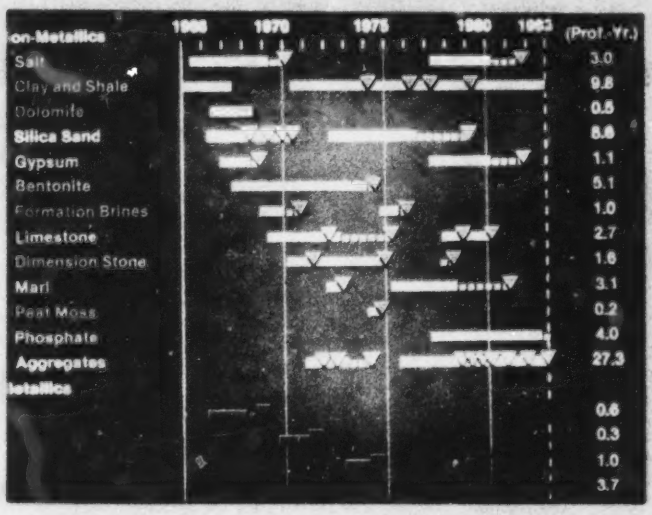
An 18-month contract was signed to continue work for Environment Canada's Atmospheric Environment Service to support their RAINSAT project designed to improve short-term weather forecasting by analyzing radar and satellite data.



In a joint activity with Alberta Environment, the Alberta Research Council initiated a three-year project to obtain airborne measurements of emissions from oil sands processing plants, particularly in the Fort McMurray area. Samples were taken by aircraft at various distances downwind from the Syncrude plant to determine the transport and dispersion of sulfur dioxide and nitrogen oxides, the transformation of them, and the redistribution and rate of removal of pollutants by clouds and precipitation. Researchers were able to trace a plume of emissions 96 km from its source, measuring aerosol concentration in various sizes and calculating transformation rates of sulfur dioxide to sulfates (sulfur particulates).



A geologist examines a section of silt and clay as a potential source of raw material for synthetic aggregate as part of the research into alternate aggregate resources.



All of Alberta's potentially important mineral commodities have been characterized and mapped at reconnaissance scales, completing a 17-year project.

Water

The Water subprogram has the major goal of integrating and expanding water sciences research in cooperation with industry and in support of development in Alberta.

A major study to evaluate the potential environmental impacts of in-situ processes in the area of the Cold Lake oil sands deposit is underway. Data collection and selection is now effectively complete and initial assessment of the regional geologic, hydrogeologic, hydrodynamic, and hydrochemical characteristics of major hydrostratigraphic units is in progress. The next main work to be done is construction of a three-dimensional finite element model for the study of groundwater flow in the stratigraphic sequence above the Middle Devonian Prairie Evaporite Formation and in an area where more than half the proposed in-situ recovery projects will be located.

Researchers completed a study in the Athabasca area regarding the impact of oil sands mining on the hydrologic response and sediment yield of a small watershed. The study revealed that the muskeg cover absorbed precipitation and during retention, about 80 percent of the water was evaporated. The remaining 20 percent was slowly released as runoff. Measurements in areas where the muskeg was removed indicate that up to 50 percent of the rainfall may quickly run off. Furthermore, significant erosion of the exposed soil could occur, thus increasing the amount of sediment flowing into local streams. The results of the study can be used as an aid in planning conservation measures to lessen the negative impact of oil sands development.

Urban hydrologists have determined and predicted the increases in peak flows of water runoff following storms and other qualitative changes associated with various levels of urbanization. They have not seriously considered, however, the extent urbanization has increased annual water yields. Supported by the Alberta Research Council, a graduate student at the University of Alberta completed a study towards a doctoral thesis on the balance of three water basins in the City of Edmonton. The study indicated annual water yields of the area occupied by the city were approximately equal to water used annually by the city. Knowledge of this source of water, largely overlooked in the past, could lead to more accurate decisions by water basin planners, city water managers, city engineers, land developers and consultants.

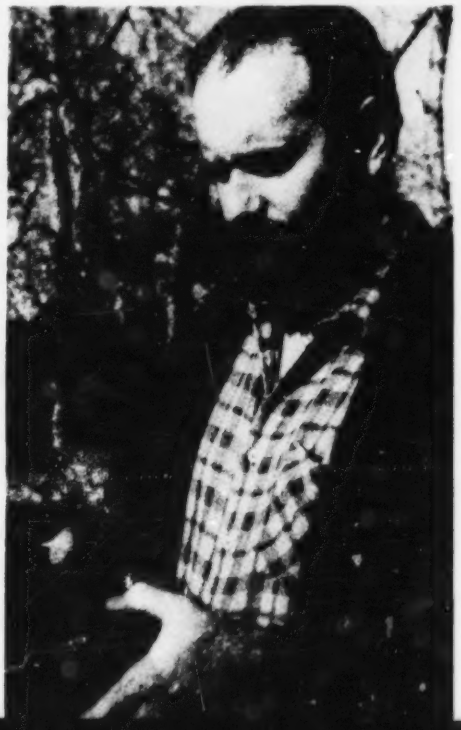
In the field of aquifer and well hydraulics, specific analytical models have been developed and tested for more accurate evaluation of the production potential for aquifers in

Alberta which are not similar in nature (normally, aquifers are similar in nature throughout a given area and methods for interpretation are already available).

Land

As Alberta companies continue to mine surface coal in the plains region, the Alberta Research Council is developing a framework for predicting the impact of that mining on local and regional water resources and determining the probability of long-term success in land reclamation.

Current reclamation practices are designed to make land at least as productive as it was before it was mined, but maintaining that productivity on a long-term basis is not yet assured. Research has concentrated on the design of a landscape that will not be degraded by salt transported to the soil by subsurface water. Data on patterns of groundwater recharge, flow, and discharge, and chemical evolution of the water in the landscape prior to mining have provided a basis to predict the flow patterns and chemistry following mining. Research has shown that discharge of groundwater to the surface generally will not contribute substantially to salinization of soil in reclaimed landscapes. Where the water table is too close to the surface, however, salt can be carried upward through capillary movement. Research is continuing on the material and slope characteristics necessary to design a landscape where the water table is far enough beneath the surface to minimize this upward transfer of salt to the soil.



Soil researchers' productivity has increased considerably since they started using a polycorder, an electronic notebook and data logger which can transfer field data afterwards directly to a computer.

Additional land resource studies include investigations of the Quaternary geology of various parts of the province including the Cold Lake region. Soil survey reports were completed for six areas in the province. They included an inventory of the soil resource plus interpretations relevant to agriculture (1 report) and recreation (4 reports).

Earth Resources

Geological survey and research studies explain the geological framework of the province, and place emphasis on the nature and origin of Alberta's mineral and energy resources, which are a cornerstone for Alberta's economic development.

The most significant achievement of 1983 was the completion of province-wide inventories for all of Alberta's important mineral resources. With completion of the Alberta phosphate survey, the inventory of Alberta's ceramic clays, and the Athabasca Basin uranium study, virtually all of the potentially important mineral commodities in the province except sand and gravel have been characterized and mapped at reconnaissance scales. This work, over a period of 17 years, includes the industrial minerals: ceramic clays; bentonite; marl; limestone; dolomite; silica sand; salt; gypsum; dimension stone; phosphate and aggregate. It includes the metallic minerals: iron; uranium; lead-zinc. Some 74 man-years of research have been involved.

In recent years, new studies were started on hydrocarbon accumulations in the Alberta subsurface. Petroleum geology research, supported in part by Alberta Energy and Natural Resources, has resulted in surprising new insights into the nature and origin of a number of problematic fields of oil and gas trapped in original deep basins and not allowed to seep over time closer to the surface where they are normally recovered. Researchers determined that the sandstone surrounding the basins was compacted with other materials during its original deposition, rendering it impermeable. In addition, regional subsurface mapping in north-central Alberta has succeeded in establishing a sound geological basis for renewed exploration in a number of limestone and dolomite formations.

Another project completed in 1983 was a major study in palynology, which deals with the preserved remains of pollen and spores. There are two fundamental reasons why detailed palynological work on Cretaceous strata in Alberta constitutes a research priority. First, rocks of Cretaceous age (deposited between 60 and 120 million years ago) contain a very large proportion of Alberta's energy resources, and continued exploration success depends on the detailed kind of stratigraphic insight that can only be provided by precise palynological knowledge. Second, by virtue of the fact that many Cretaceous successions in Alberta represent relatively continuous depositions in settings conducive to rich microflora yield, there is a certain scientific responsibility on the part of the Alberta Research Council to contribute to the pool of research information for use in all parts of the world, in return for being a user of that knowledge. The completion of this third monograph on Cretaceous microfloras marks the culmination of this type of research in Alberta.

Sediments transported and deposited in many of Alberta's rivers contain trace amounts of gold and other precious metals. Until now, concentrations were generally considered to be of insufficient grade to warrant placer development. Increased interest in gold, spurred by price increases, has altered this traditional perception to the point that the Aggregate Inventory Project has been broadened in scope to include the capturing of data on gold concentrations in modern alluvial sediments and in sands and gravels deposited by rivers in the last million years.

The Alberta Research Council operates six information centers to provide information for industry, government, the general public and staff. The major research programs also receive support from a variety of other services: technical laboratories; a computing network; machine shops; instrumentation repair; graphics; human resources; safety; financial services; editing and publications sales; public relations.

Alberta Oil Sands Information Center
The Alberta Oil Sands Information Center was established in 1975 through a grant from the Alberta Oil Sands Technology and Research Authority (AOSTRA). The center, which is managed by the Alberta Research Council, continued to operate as a central source of all published information on oil sands and expanded its service to include enhanced recovery processes and heavy oils. It responded to approximately 3000 enquiries in these areas.

The bibliographic databases were made available online on QL Systems, based in Ottawa, to add to access already available through SPIRES at the University of Alberta.

The center completed a numerical database on international information about physical properties of oil sands, in conjunction with the Alberta Research Council's Oil Sands Sample Bank. Another online database, the Oil Sands Researchers and Projects File, was expanded to include those working in the heavy oil and enhanced recovery fields. A bi-monthly newsletter, *the TAR Paper,* was distributed to over 1700 subscribers in 28 countries.

Each computing center designed to support a specific area of research is linked to other computing centers throughout the Alberta Research Council to form a network which has become an effective resource.

Coal Technology Information Center
The Coal Technology Information Center is jointly funded by the Alberta Research Council and the Alberta/Canada Energy Resources Research Fund, administered by Alberta Energy and Natural Resources. The center provides information on mining technology, coal beneficiation, coal conversion, combustion, environmental aspects and energy policy.

During 1983, it responded to 4000 enquiries from researchers, industry, government, academia and the public. Also, the computer information system, Coal-Abs, which is available online through SPIRES at the University of Alberta, increased by 3500 entries to a total of 13,500. Two publications were produced by the center for subscribers: the Current Acquisitions Bulletin, a semi-monthly update of new material added to the database; the Coal-Abs Index, a cumulative list of holdings in the database.

Information Geology
The Information Geology function of the Alberta Geological Survey has over 5000 records of geological literature on file in the GEODIAL database. Commercial use of the service is increasing. The past year has seen the input of serial literature into GEODIAL, the promotion of the database through workshops and individual contacts, and an increase in both the use of the database and the number of outside enquiries.

Industrial Information
The Industrial Information center interacts mainly with manufacturers, as part of the Industrial Development subprogram. Clients in Alberta have access, through offices in Calgary and Edmonton, to 95 percent of the world's published scientific and technical literature in the more than 500 databases of 10 computer systems in Canada and the United States. This service is provided to people representing industry and government. Over 400 enquiries resulted in 1500 individual bibliographic searches.

SWERP Information Center
The SWERP (Solar and Wind Energy Research Program) Information Center is operated under a contract funded by the Alberta/Canada Energy Resources Research Fund. The center collects and disseminates information on solar and wind energy and related technologies. In 1983, over 3500 information requests came from the general public, governments, industry and commercial sectors, educational institutions and other libraries and information centers. Staff continued to improve their capabilities in database management and development. With the aim of providing a database that meets international standards for bibliographic exchange of information, the Canadian Renewable Energy Database, ENERCAN, was developed and expanded from a prototype into an operational database which the National Research Council intends to make publicly available in 1984. The SWERP Information Center has continued to respond to an increasing number of enquiries on renewable energy and remains a key focal point for online access to information in this subject area.

Library
A strong information support system is essential to the Alberta Research Council's effectiveness as a research center. Library Services provided a library collection to support current research through its locations at Terrace Plaza, the Campus Building and Clover Bar with its collection of 50,000 books and government documents. It responded to approximately 9200 information requests from staff and 3500 external information requests for a total increase of almost 11 percent over last year. SCITECH, a joint library management

project with Alberta Agriculture and Alberta Environment, provides computerized bibliographies of international scientific and technical literature held in three collections. SERIALS provides computerized access to the collection of 650 journals.

Analytical Services
The Chemistry Analytical Laboratory conducted analyses for projects in all four research divisions of the Alberta Research Council, private industry and various government departments including Alberta Energy and Natural Resources, Alberta Farmer's Advocate, Alberta Occupational Health and Safety, Environment Canada, and the Royal Canadian Mounted Police. Approximately 40,000 inorganic analyses were conducted during the year and 1900 other samples were analyzed using various spectroscopic techniques — gas chromatography/mass spectrometry, nuclear magnetic resonance, infrared, and x-ray fluorescence.

The Coal Analytical Laboratory provided analyses of coal and coal-derived products in support of the two major coal conversion projects, liquefaction and pyrolysis. In 1983 a computerized system of laboratory data storage and retrieval was established, a novel method of base line treatment in simulated distillation by gas chromatography has been developed and the combination of simulated distillation with vacuum thermogravimetric residuum determination has been introduced for samples containing non-distillable material. Reflectability of thin-layer chromatographic class separations using flame-ionization detection has been demonstrated, rendering the method useful for first class analysis of heavy fossil liquids and residua. The laboratory also participated in round robin tests organized by CANMET (Canada Center for Mineral and Energy Technology) and ASTM (American Society for Testing and Materials) and provided advisory services to outside clients.

The Gasoline and Oil Laboratory assisted government departments and industry with a wide range of testing and inspection services to assure quality of transportation fuels and lubricants. It coordinated three sample exchange programs across Canada among petroleum testing laboratories. This program helps maintain high laboratory standards and accurate test methods.

The Oil Sands Analytical Laboratory supported the projects in the Oil Sands Research Program. It also provided a range of specialized analytical services to other research programs in the Alberta Research Council and to government departments and industry. It coordinated inter-laboratory sample exchange programs in the analysis of oil sands which resulted in the adoption of a reference method for the determination of oil, water and solids in oil sands. The laboratory continued efforts to improve analytical methods related to the study of bitumen, oil sands and production fluids — specifically it improved the reliability in analysis of anions and cations present in production fluids from in situ recovery processes. The laboratory installed a computerized x-ray diffractometer to aid in the study of clay minerology in support of projects studying oil sand reservoirs and the effects of the reservoir on oil recovery.

The Sedimentation Analytical Laboratory supported geological studies by preparation of 930 thin-sections of rock or sediment samples, 200 size analyses of sand, silt and clay and over 1000 other sample preparations. These were in support of studies in oil sands, mineral resources, sedimentary geology and Quaternary geology.

The Alberta Soil Survey Analytical Laboratory is operated jointly by the Alberta Research Council and Agriculture Canada to provide analytical support for soil survey and research projects. The laboratory provided 24,700 analyses on 1680 soil samples in support of soil studies during the year.

Computing Services
Specialized computer systems support many of the research programs. To achieve the efficiency of sharing hardware, software and personnel, the Alberta Research Council has established a 15-node, in-house computer communications network.

Staff in the Groundwater Department constructed, tested and implemented the core software for a new geographic plotting package.

Machine Shop
The Machine Shop is an essential facility at the Alberta Research Council for building research apparatus to researchers' specifications. During 1983, the Machine Shop was devoted largely to the coal research facilities at Nisku in the maintenance, construction and installation of high pressure and high temperature apparatus. It also continued to provide services for oil sands research, provided maintenance service on the weather radars in Red Deer and apparatus for chemistry and industrial and engineering research projects.

Instrument Repair
Instrument repair maintains a major portion of the analytical and electronic equipment in the Alberta Research Council. In the past year it continued to assist in the installation of the expanding network of in-house computers and terminals. It also assisted in the completion of the network of monitoring stations connected with the Solar and Wind Energy Research Program. Over the past year it provided assistance in setting up the testing facilities for the Forest Products testing lab at the Parsons Property building.

In addition to cartography, Graphic Services provides drafting and photographic services.

Graphic Services
Cartography is one of the main functions of Graphic Services (formerly Drafting Services), largely in support of the Natural Resources Research Program and of the geological aspects in the Oil Sands and Coal

Research Programs. During 1983, Graphic Services completed 48 aggregate resource maps of Central Alberta, 1 oil sands geology map of the Fort McMurray area, 5 soil maps of various provincial parks and 1 soil map for Beaver County, 2 surficial geology maps of Calgary, 4 geology maps covering the Bocquene-Turtle Lake area, and a hydrogeology map of the Wadlin Lake-Vermilion Chutes area. It also provided extensive drafting and photographic services for technical reports, presentations and public relations projects. Mechanical drafting services are supplied to oil sands research at Clover Bar, and to coal research at Nisku.

Human Resources
The Human Resources Department has continued development of human resources policies, and assisted several line departments with defining and implementing manpower plans based on organizational restructuring. The department also supported the recruitment activities by visiting university campuses across Canada to interview and counsel students on careers in research. As well as implementing in-house training programs on performance appraisal, technical report writing and supervisory development, the department developed formal policies dealing with recruitment and selection, pay administration, performance appraisal, and occupational health. Expansion of personnel systems and procedures to support increased administrative reporting needs continued throughout the year. The pre-employment medical assessment program was fully implemented, and negotiations for a new collective agreement.

Financial Services has introduced a fixed asset accounting and inventory system as part of a major revision of administration procedures at the Alberta Research Council.

Financial Services
The Financial Services Department is responsible for the planning, direction, coordination and control of the Alberta Research Council's financial assets and resources and the timely recording and reporting of all financial activity. The Alberta Research Council has been implementing a fixed asset accounting system, including complete inventory of all fixed assets, has acquired a VAX 11/750 Digital computer together with the purchase of a packaged accounting system for project costing and reporting.

Safety
The Safety Office is responsible for ensuring that the Alberta Research Council meets its safety commitments with regard to federal and provincial health and safety regulations, by designing appropriate internal policies, regulations and standards. The Safety Office managed the volunteer services of 171 staff members who acted as evacuation wardens or served on safety committees and emergency squads. During 1983, training for the emergency squads included industrial fire fighting courses at the Vermilion Fire School. The Alberta Research Council now has a total of 10 qualified industrial fire fighters. Major accomplishments also included development of the following: pressure vessels quality control program; standard laboratory guidelines; an accident and reporting policy; facilities engineering operations manual for the coal research building in Nisku.

Editing and Publications Sales
Editing and Publications Sales provided editorial services, typesetting, design, layout, and distribution of the Alberta Research Council's technical reports and other publications. Improvements in customer service included an expanded and updated author/subject index available online, and a computerized inventory control system. Also, the mailing list increased by 1000 names. The capacity to distribute throughout the province increased when Alberta Energy and Natural Resources agreed to handle Alberta Research Council publications. Productivity also increased with the addition of a phototypesetter/computer interface, allowing some reports to be produced in 3 to 4 months instead of the 6 to 12 months required previously, resulting in a 40 percent increase in production over 1982.

Public Relations
In addition to assisting the line departments with their public relations requirements, the Public Relations unit produces two newsletters to inform staff and the public about the Alberta Research Council's research activities. *Newsline*, intended primarily for staff, is also distributed to government departments and the news media. The Alberta Research Council's *R & D* is designed to inform and encourage industry to avail themselves of the expertise available. A major project of the Public Relations unit during 1983 was the change in visual identity, which is reflected on the cover of this report. It also coordinated special events such as a speech to Calgary industry, university and news media representatives and an open house for Edmonton industry, government and university representatives.

Financial Statements

ALBERTA LEGISLATURE
OFFICE OF THE AUDITOR GENERAL

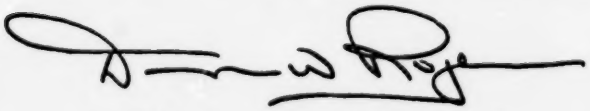
Auditor's Report

To the Board of Directors of
The Alberta Research Council

I have examined the balance sheet of the Alberta Research Council as at March 31, 1983 and the statements of revenue, expenditure and operating surplus for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances, except as explained in the following paragraph.

As disclosed in Note 6 to the financial statements, the Council has entered into research contracts which specify that the Council does not receive title to fixed assets purchased until completion of the contract or at the discretion of the sponsor. Since the Council did not identify those fixed assets to which it may not have title, I was unable to determine if any adjustment might be required to the balance sheet to adjust fixed assets and contributed surplus to reflect ownership of the assets.

In my opinion, except for the effect of adjustments, if any, which I might have determined to be necessary had I been able to identify assets to which the Council may not have title as described in the preceding paragraph, these financial statements present fairly the financial position of the Council as at March 31, 1983 and the results of its operations for the year then ended in accordance with the disclosed basis of accounting, considered appropriate in the circumstances, as described in Note 2 to the financial statements applied, except for the change in the method of accounting for capital leases as described in Note 3, on a basis consistent with that of the preceding year.



C.A.
Auditor General

Edmonton, Alberta
November 2, 1983

STATEMENT A

ALBERTA RESEARCH COUNCIL
BALANCE SHEET
AS AT MARCH 31, 1983
(thousands of dollars)

Assets	1983	1982
Current:		
Cash	$ 8	$ 6
Deposits in trust (Note 4)	4,992	4,012
Accounts receivable	4,254	3,046
Prepaid expenses	48	49
Advances to joint venture (Note 5)	182	-
	9,484	7,113
Other:		
Government of Canada and Provincial bonds, at cost (approximate market value: 1983 $7,823; 1982 $8,993)	8	10
Fixed:		
Equipment (Note 6)	19,355	15,157
Trust Fund:		
Deposits in trust (Note 4)	2,426	793
	2,426	793
Total	$31,273	$23,073

Liabilities and Surplus	1983	1982
Current:		
Accounts payable	$ 3,504	$ 3,462
Deferred contract revenue	459	607
Obligation under capital lease	66	-
Advances payable, Province of Alberta	150	167
	4,179	4,236
Non-current:		
Obligation under capital lease (Note 7)	235	-
Equity:		
Contributed surplus (Note 8)	19,054	15,157
Operating surplus, Statement B	5,379	2,887
	24,433	18,044
	28,847	22,280
Trust Fund:		
Trust liability (Note 10)	2,117	660
Accounts payable	309	133
	2,426	793
Total	$31,273	$23,073

STATEMENT B

ALBERTA RESEARCH COUNCIL
STATEMENT OF REVENUE, EXPENDITURE AND OPERATING SURPLUS
FOR THE YEAR ENDED MARCH 31, 1983
(thousands of dollars)

Revenue	**1983**	1982
Grant from province of Alberta, Department of Executive Council (Note 9)	**$18,951**	$15,000
Contract revenue	**17,978**	14,978
Other income	**298**	313
	37,227	30,291
Expenditure		
Energy Resources Division	**11,253**	9,550
Natural Resources Division	**10,529**	9,504
Industrial and Engineering Research Division	**5,412**	4,302
Administration Division	**3,641**	3,092
Frontier Sciences Division	**3,103**	2,765
Executive Offices	**797**	682
	34,735	29,895
Excess of revenue over expenditure for the year	**2,492**	396
Operating surplus at beginning of year	**2,887**	2,491
Operating surplus at end of year	**$5,379**	$2,887

The accompanying notes are part of these financial statements.

ALBERTA RESEARCH COUNCIL
NOTES TO THE FINANCIAL STATEMENTS
MARCH 31, 1983

Note 1 Authority

The Alberta Research Council operates under the authority of the Alberta Research Council Act, Chapter A 35.1, Statutes of Alberta 1981.

Note 2 Summary of Significant Accounting Policies and Reporting Practices

(a) General: These financial statements have been prepared in accordance with generally accepted accounting principles except that no provision for depreciation on fixed assets has been made. Purchases of operating fixed assets are charged to operations in the year and are shown on the balance sheet at original cost or at estimated cost with the offsetting credit to contributed surplus.
(b) Capital Lease: The Council follows the policy of capitalizing assets leased from others with respect to capital leases entered into after April 1, 1982 (see Note 3).
(c) Occupancy and Office Furniture Expenditure: Occupancy and office furniture have been provided by the Province of Alberta at no cost and are not reflected in these financial statements.
(d) Patents: Expenditures for patents owned by the Council as a result of research activity are not capitalized due to the intangible nature of assets that may accrue to the Council.
(e) Investments: The Council has become an equity participant in external organizations as a result of conducting certain research activities. The Council's equity in these external organizations is not material and is therefore not reflected in these financial statements.
(f) Changes in Financial Position: A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3 Changes in Accounting Policies

During the year, the Council adopted the policy of capitalizing assets leased from others with respect to capital leases entered into after April 1, 1982 and which transfer to the Council substantially all the benefits and risks incident to ownership of the assets. The leased assets so capitalized are initially recorded as fixed assets at cost and the related lease obligations as liabilities. The lease obligations are reduced over the lease term as lease payments are made.

Note 4 Deposits in Trust

Deposits in trust consist of amounts held in the General Trust Fund of the Province of Alberta.

Note 5 Advances to Joint Venture

During the year the Council advanced $250,000 to a joint venture for research. The Council's share of the joint venture's expenses of $67,816 in 1982/83, net of interest credited on the Council's advances is included in the expenses of Frontier sciences division on Statement B.

Note 6 Fixed Assets

Fixed assets purchased subsequent to April 1, 1981 have been valued at cost. Those purchased prior to April 1, 1981 have been valued at estimated cost by the Council.

	1983	1982
Balance at beginning of year	$15,157,087	$11,449,468
Additions at cost	4,868,005	3,707,619
	20,025,092	15,157,087
Write-off	669,555	-
Balance at end of year	$19,355,537	$15,157,087

Included in fixed assets are certain fixed assets purchased as a result of research contracts which specify that the Council does not obtain sole title to the fixed assets until completion of the contracts or at the discretion of the sponsor.

The Council completed a review of equipment records during the year and revised the method of capitalization. To conform to the new method and to remove the value of items written off or disposed of in prior years, the recorded cost of equipment and contributed surplus has been reduced by $669,555.

Note 7 Obligation under Capital Lease

The following is a schedule of future lease payments under the capital lease together with the balance of obligation under capital lease.

Year ending March 31	
1984	$121,698
1985	121,698
1986	186,978
	430,374
Less: Interest	129,217
Balance of the obligation	301,157
Less: Current portion	65,834
	$235,323

Note 8 Contributed Surplus

Contributed surplus represents Council's equity in fixed assets and consists of the following:

	1983	1982
Balance at beginning of year	$15,157,087	$11,449,468
Purchases during the year	4,566,848	3,707,619
	19,723,935	15,157,087
Write-off	669,555	-
Balance at end of year	$19,054,380	$15,157,087

The difference between contributed surplus and fixed assets as disclosed on the balance sheet is represented by obligations under capital lease.

Note 9 Grant from the Province of Alberta

In addition to the grant of $18,951,000, the Council received $197,000 from the Province of Alberta for the operation of the Office of Science and Technology. This amount, net of expenditure, is included in Trust.

Note 10 Trust Liability

Trust funds are contributions received from other government departments under research agency agreements which specify the Council administer the contributions and provide accounting services.

	1983	1982
Balance at beginning of year	$ 660,341	$ 1,097,547
Contributions	4,700,721	2,693,229
	5,361,062	3,790,776
Expenditure	3,244,559	3,130,435
Balance at end of year	$ 2,116,503	$ 660,341

Note 11 Contractual Obligations and Commitments

The Council has become a participant in long term research projects where commitments have been made to purchase fixed assets at a cost of $1,017,163.

Note 12 Contingent Liabilities

The Council is a defendant in a number of legal proceedings. Claims against the Council in these proceedings, which have not been reflected in the accounts, amount to $500,000. While the ultimate outcome of these proceedings cannot be predicted at this time, it is the opinion of management that the disposition of these cases will have a minor effect on the financial position of the Council.

Note 13 Comparative Figures

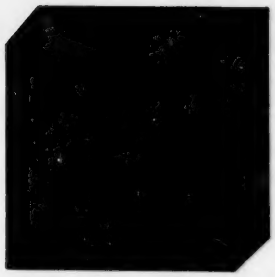
The 1982 figures have been restated where necessary to conform to 1983 presentation.

Note 14 Approval of Financial Statements

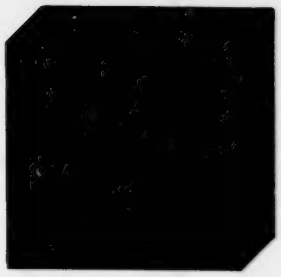
These financial statements were approved by management on November 2, 1983.

Budget for the Year Ending March 31, 1983 ($000)

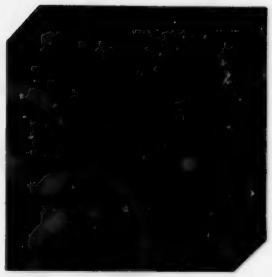
Natural Resources	$ 5,801 (G)	
	$ 6,531 (C)	
	$12,332	
Oil Sands:	$ 2,374 (G)	
	$ 5,831 (C)	
	$ 8,205	
Coal:	$ 1,013 (G)	
	$ 4,013 (C)	
	$ 5,026	
Industrial and Engineering:	$ 4,737 (G)	
	$ 2,743 (C)	
	$ 7,480	
Frontier Sciences:	$ 3,609 (G)	
	$ 133 (C)	
	$ 3,742	
	$36,785	



Natural Resources $12,332

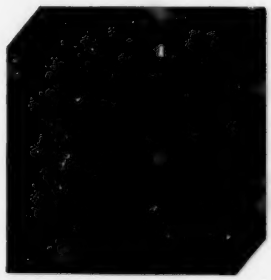


Oil Sands $8,205



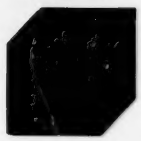
Coal $5,026

Industrial and Engineering $7,480



Frontier Sciences $3,785

(G) Grant



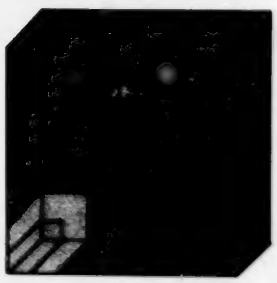
(C) Contract

Sources of Funds ($000)

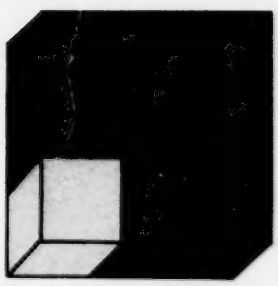
- Government Grant . . . . . $ 17,534 (48%)
- Contracts from the Provincial Government . . . $ 16,789 (46%)
- Contracts from Industry and Other . . . . . $ 1,956 (5%)
- Contracts from Federal Government . . . . . $ 506 (1%)

Expenditures ($000)

- Manpower . . . . . $ 20,237 (55%)
- Supplies & Services . . . . . $ 11,680 (32%)
- Fixed Assets . . . . . $ 4,868 (13%)



Sources of Funds ($000)



Expenditures ($000)

Board of Directors

MR. E.C. MUSGREAVE[1] (Chairman)
Member of the Legislative Assembly

THE HONORABLE H. PLANCHE
Minister of Economic Development

THE HONORABLE D. JOHNSTON
Minister of Advanced Education

DR. C.W. BOWMAN
Chairman, Alberta Oil Sands Technology and Research Authority, Edmonton

MR. B.W. BROOKER, P.Eng.[1]
President, B.W. Brooker Engineering Ltd., Edmonton

DR. K.E. COOPER[2]
Vice-President (Research), University of Calgary, Calgary

DR. R.M. HARDY, P.Eng.[2]
Chairman of the Board, Hardy Associates (1978) Ltd., Edmonton

MR. J.H. NODWELL
President, Canadian Foremost Ltd., Calgary

DR. J.G. KAPLAN
Vice-President (Research), University of Alberta, Edmonton

MR. J.E. PIKE[1]
Retired Businessman, Wetaskiwin

DR. D.R. STANLEY[1]
President, Stanley Associates Engineering Ltd., Edmonton

MR. A.F. TOTTRUP, P.Eng.[1]
President, Oil Recovery Engineering Ltd., Edmonton

MR. M.M. WILLIAMS[2]
President and Chief Executive Officer, TransAlta Utilities Corporation, Calgary

DR. G.G. CLOUTIER (resigned August, 1983)
President, Alberta Research Council, Edmonton

DR. R. GREEN[1,2]
Deputy President, Alberta Research Council, Edmonton

[1] Executive Committee
[2] Salary Schedule Advisory Committee

Senior Management Staff

DR. R. GREEN, Deputy President[1] Vice-President, Operations	Terrace Plaza
DR. H.W. HABGOOD Special Assistant, University Liaison	Terrace Plaza
MRS. D.M. HOLLANDS Corporate Secretary and Director of Public Relations	Terrace Plaza
DR. E.A. BABCOCK Vice-President, Natural Resources Division	Terrace Plaza
MR. W.J. CHERPETA Vice-President, Finance and Administration Division	Terrace Plaza
DR. D.J. CURRIE Vice-President, Frontier Sciences Division	Campus Building
DR. J.G. DOUGLAS Vice-President, Energy Resources Division	Terrace Plaza
DR. D.L. MITCHELL Vice-President, Industrial and Engineering Division	Terrace Plaza

[1] In January 1983, Dr. Green was appointed Vice-President, Operations. In August 1983, he was named Deputy President upon the resignation of Dr. G.G. Cloutier.

The Executive Offices are located at
7th floor, Terrace Plaza
4445 Calgary Trail South
Edmonton, Alberta
Canada, T6H 5R7

POOR

QUALITY

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